THE

ENGINEERING MAGAZINE

VOL. XI. JUNE, 1896. No. 3.

THE FRUITS OF FRAUDULENT RAILROAD MANAGEMENT.

By J. Selwin Tait.

IN the case of municipal mismanagement and corruption a country's "dirty linen" can be washed at home, and the world at large not be made unpleasantly aware of the process or the need thereof. In the improper handling of its finances, however, that is, of securities which have an international importance, its "dirty linen" is washed in the thronging centres of every great monetary nation, to the mortification, discredit, and loss of the country of issue.

Thanks to its enormous natural advantages, the United States is to-day the richest country in the world, and this while its resources are not half developed. Under ordinary conditions, the disparity between its wealth and that of the richest of European countries must become more and more conspicuous, because the natural wealth of Europe has already been realized and added to its available assets, while this country is still largely undeveloped, and a great appreciation in its wealth is inevitable.

Here, then, we have a condition of affairs which ought to place our government securities, our railway stocks and bonds, and all our investment stocks at the head of every competing security in the world, and American investments ought, without effort and simply by the natural process of rising to their proper level, to be more in demand than those of any other country. Such is the heritage which the youthful financier, or investor, should feel to be his own on entering Wall Street for the first time; yet what does he find? Well, suppose he takes up a copy of the latest London *Statist*, one of the two principal financial papers of the greatest investment city in the world, and a paper which does much in moulding public opinion, he reads:

The Baltimore default heightens the existing distrust by investors of American se-

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curities. Investors have no safeguard that the financial position of any company is what its reports state it to be. . . . We cannot but reiterate our advice to the British public not to take any interest whatever in the American share market.

This may seem a somewhat harsh and sweeping judgment, when we call to mind some of our really high-class American railway stocks; but, as Matthew Marshall points out in a recent article in the *Sun*:

Time was when Baltimore & Ohio stock paid regular dividends of ten per cent. per annum and stood at 191 per $100 share. That in the short space of ten years it should have fallen to where it is now cannot but make the holders of New York Central, Boston & Albany, New York & New Haven, Pennsylvania, and similar first-class stocks pause and consider whether they too may not, in the course of ten years or so, not only see their dividends disappear, but be called upon to put their hands in their pockets for contributions to rescue the shattered remnants of their property from complete destruction. Such a view is illogical, but it is natural.

And this is where one of the very worst effects of the engendered distrust appears. It is like an outbreak of rabies, where even one infected dog will put a whole country-side under suspicion.

In our Union Pacific, Northern Pacific, Reading, Atchison, and Erie railways, and in our Cordage and other industrial companies of similar stamp, hundreds of millions of dollars have been lost, and at the present moment there are not less than two hundred important railways and other large corporations in the hands of receivers. The result is wide-spread distrust at home, and such utter discredit abroad that, while British consols stand at 113, and the Bank of England rate is two per cent., and while three per-cent. municipal stocks are being applied for ten times over, and sold at a premium, the investors of Great Britain will not touch our securities at any price. Our railroad securities enjoy the proud distinction now of ranking alongside the defaulting bonds of the effete governments of Europe and of rubbing shoulders with the output of Spain, Portugal, Greece, and Turkey. But even here we wrong these poor countries by such a comparison, for they paid while they could, and they never had any intention of deceiving the investor, and were never accused of juggling with their books.

The principal source of distrust in our railways—apart from reckless competition and the physical conditions of the country—and also in our other corporations under suspicion is the manipulation of the accounts. While it is probably safe to say—and I say it on good authority—that the books of such railway companies are as well kept as they are in any other country, in so far as good book keeping is necessary for the proper working of the business and the prevention of loss from fraud by employees, the manipulation of the various accounts by the presidents or other high officials of such corporations to suit their own views or interests is so well proved and is such a monstrous offence

against public morals, both in itself and in its ruinous results, that the only wonder is that it has been endured for a moment, or that Europe ever trusted us with a dollar, after it had learned our methods.

The results of the dishonest management of our corporations are both deep and widespread. They affect the engineer, the superintendent, and all officials. In fact, their malign influence overshadows all classes from the man of wealth to the man who carries a hod.

The loss or reduction of wages or emoluments is not the consequence I allude to. One of the most direct results of the dishonesty referred to, and yet one I have never seen mentioned, is the high price of real estate in our cities, and the correspondingly heavy rents. The general distrust of all forms of investment brought about by the mismanagement of our railways and other corporations, and by the continued manipulating of the market in Wall street, has caused the withdrawal of the investor from that class of security; and, with no form of stock investment in sight which he approves, he puts his money into one or more savings banks, where, though the interest is moderate, he feels the principal at least to be safe. To such an extent has this been done that the aggregate deposits in the savings banks of New York State exceed those in all the savings banks in Great Britain.*

Does this mean that the Americans are a more thrifty people? Not at all. It indicates a defect greatly to be deplored,—the absence of any other investment which the people believe in. The whole trend of the savings bank of to-day is to educate its depositors to the value of real estate. The savings banks themselves invest very largely in it, and in mortgages of realty, and, when the depositor withdraws his money, he follows the example of the bank.

Thus the reprehensible methods of our corporations, which have driven thrifty people away from other legitimate investments, have forced them to concentrate their attention, not only recently, but for decades, upon real estate, and tens of thousands of individuals, beside numerous great investment corporations, are interested in real estate to-day who, in other countries, and here under other circumstances, would have embarked their money in the stocks and bonds of corporations honestly and profitably managed, much to the advantage of these corporations and the good of the investor.

Turning to the reverse side of the shield, the fierce competition for real estate engendered in the way described has driven the price of realty in our cities, where it is better adapted for investment, to such figures that the rents are out of all proportion to what they are in more thickly populated European countries. In cities like New York

* In 1893-4 the total deposits in the public and private Savings Banks of the United Kingdom were $595,780,052; of N. Y. State $617,089,449 and of the U. S. $1,739,006,705.

this condition of affairs has practically destroyed the possibility of a home for the individual of small or even moderate means, who, with like income abroad, could have a house of his own. The overflowing tenement and the only less crowded "flat"—the high rent for that which is not a home in the old-time acceptance of the term—is the result of, and is directly traceable to, our dishonest corporation management.

But there are some men who prefer a higher rate of interest than that allowed by savings banks, or the dividend ultimately receivable from real estate, and these men embark their savings in trade, not necessarily, or even commonly, in their own line of business, but in some other line which seems to them in their ignorance to offer promise of large returns; for no man knows the keenness of the competition in any business outside his own, until he has engaged in it.

This handling of spare capital by engaging in another business is peculiar to this country, and is, as stated, the outcome of the distrust prevailing with regard to our corporation investments. In all other established countries it is customary for a man to stick to the business to which he was brought up. He thinks that is the only business he knows, and he judges rightly. The outcome of the custom here is that the competition in trade is keener and more fierce than in any other country in the world, and, now that this country has passed its "booming" stage, business is less profitable to those engaged in it than it is in other countries of average activity; and it is likely to become still less remunerative.

For sixty or seventy years, but more actively since the passage of the limited liability act a third of a century ago, the people of Great Britain have entrusted their savings and their inheritances to corporations, and, notwithstanding all that is said to the contrary, they have profited hugely by doing so. And no little of the commercial supremacy of that country is due to the fearlessness or faith of her investors, based on a well-grounded belief in the integrity and judgment of the directors and managers of her corporations. It is absolutely amazing to look back upon the courage with which a thrifty and careful people like the Scotch have thrown their bread upon the far-off waters of the British colonies, for instance, and have seen it come back in wealth to them in later days. The one thing which saved them was the honesty of their officials. Even where their investments were not as good as anticipated, or where the vendors had made representations not borne out by facts, good management and honesty brought the investors out all right. Honesty and the confidence it inspires were the Alpha and Omega of the entire business.

It is only by glancing at what a country, no better situated than

our own, has gained by honest commercial management that we can measure what we have lost, and are losing, by the dishonesty and infamous trickery of those corporations which have debauched our country's credit and stained its reputation.

In a copy of the London *Statist* just received I find particulars of the year's working of three groups of corporations representing as many different kinds of industries. One of these groups represents trading corporations, the others manufacturing corporations. Two of these groups embrace a capital of $612,000,000, on which the average dividend is eight per cent. per annum ; the capital of the other group is not stated, but the group embraces 418 corporations, and the dividend averages over eight per cent. per annum. These particulars are taken at hazard out of an English financial paper. The capital here referred to is a small percentage of what is invested in Great Britain in trading and manufacturing companies.

In passing, I would say that there is another objectionable feature of our financial system indirectly traceable to our corporation mismanagement. The keen rivalry in trade brought about by the undue competition referred to has made it apparent that profit can be made only by combinations of huge capital, and thus we have the Trust, which is no sooner formed than its directors—carried away by the opportunities it affords—make it a vast stock-jobbing scheme.

Corporations, as institutions, had many difficulties to encounter in Great Britain, at the outset. The company promoter was, in the past, and with a few exceptions, a shark of the most voracious kind, and his nature is the same now, although he has no longer the opportunity of fixing his own profit, as in the earlier years. His means of "bleeding" the new company, however, always ended with the transfer of the property bought by it. He rarely undertook the formation of any company—probably never, at his own risk—where a property was not taken over by the corporation. His method was to add a round sum to the purchase money, and to hand over the property at the higher figures, the difference being his "plunder." His special facilities for floating companies are now shared by others, such as respectable houses and corporations of issue, and the Companies Acts have further limited his opportunities.

Among the numerous provisions and amendments of the Companies Acts, for the incorporation, regulation, and winding-up of trading companies and other associations, are the following, which are specially to be recommended for adoption by our own legislators:

1. The promoter—the individual who forms the company and sets it going—stands in a *fiduciary* relation to the company which he promotes, and cannot retain any undisclosed profit or secret commission.

2. Every contract, document, or matter not specifically referred to in the prospectus—and calculated in any way to influence the investors' judgment—shall be void; nor can any compliance with this provision be waived.

3. Allotment cannot be made, unless the minimum subscription named in prospectus is subscribed within twenty-eight days of issue.

4. All the directors retire at the first general meeting of stockholders; after that, one-third retire annually. Only the company in general meeting can, by special resolution, remove a director before the expiration of his period of office.

5. Directors are liable for funds improperly applied, and, if they pay dividends out of capital, they may be liable for the whole amount so paid.

6. Auditors are appointed by the stockholders at general meeting. They retire annually, and are eligible for re-election. These auditors are the agents of the stockholders. They are furnished with a list of all the company's books, and to these they have access at all times. They are empowered to demand whatever information or explanation they require from the directors. Once a year at least they make a careful examination of the accounts and vouchers, and of the balance-sheet. The latter must comply, as far as possible, with the form provided by the Companies Acts.

7. On reasonable complaint, the board of trade may cause an examination of the company's books.

8. If any director, officer, or contributory of any company destroys, mutilates, alters, or falsifies any book, paper, writings, or securities, or makes or is privy to such, he is guilty of a misdemeanor, and liable to imprisonment for two years.

9. A register of members, showing the names and the number of shares held by each, must be kept at the registered office of the company, where it must be open daily to the inspection of any member *gratis*, and of any other person on payment of the nominal fee of one shilling. Copies of such register can be obtained by any one on payment of sixpence per hundred words. There is a heavy penalty for each day of refusal.

10. Every stockholder shall have one vote for every share up to ten, an additional vote for every five shares beyond the first ten up to one hundred, and an additional vote for every ten shares beyond the first hundred. Thus the holder of ten thousand shares would have only 1,018 votes.

It is especially worthy of note that the capital stock in English companies is issued only for full value in cash, except where the vendor of the property accepts stock in lieu of cash in part payment of his property. This is mentioned in contradistinction to the custom pre-

vailing here of issuing stock against the prospective value of a road; so that in the one country the capital stock of a company always represents cash paid in and expended upon the property, and, in the other, more frequently than not, water.

Looking to the incalculable injury done to this country by corporate mismanagement in the past, and to the fact that the evil shows no signs of abatement; looking, moreover, to the continuous dislocation of our commerce, to the discouragement of foreign capital, and to the discredit into which our domestic investments are brought by it, so that our capitalists, small and large, are deprived of legitimate means of safe investment; looking to these actual results, and without considering the way in which this great country's credit and good name have been prostituted at home and abroad by railway officials who have abused their position for stock-jobbing profits,—it must seem to all right-minded men that the situation is one calling for the prompt interference of congress, either through the interstate commerce commission or otherwise.

In the interest of corporations generally, I recommend that congress should pass a general law enacting:

1. That in future all the capital stock of a railway or other corporation over which congress has jurisdiction shall represent, not future prospects, but cash actually paid into the treasury, dollar for dollar, and expended, or to be expended, upon the property; or it shall represent property, certified by competent valuers to be worth, at the time of purchase, the full value paid for it in stock.

2. That the annual or semi-annual balance-sheets shall be in strict compliance with a form prescribed by law, such form to be prepared by skilled experts and to be very specific in its requirements. These shall vary according to the character of the corporation, whether it be a transport, manufacturing, or purely trading corporation; they shall give in every case explicit directions as to the source and proper allocation of all earnings and expenditures, and shall determine what are divisible profits and what are not. That the auditors shall be elected by the stockholders, and shall have the fullest power to examine the books at all times, and to call upon the president, directors, and officials for whatever explanation or information they may require. That said auditors, who shall be public accountants of unquestioned standing, after examination of balance-sheets, vouchers, books, etc., shall sign and present to the stockholders a statement to the effect that they have examined these carefully, and that the books are properly kept, and shall exhibit a true and correct view of the company's affairs; such statement to specify any cause of complaint which has come under their notice.

3. That the Companies Acts of Great Britain, which represent the costly experience—as well as the wisdom—of half a century in regulating corporations, be carefully examined, and such regulations as are adapted to this country be considered with a view to adoption. That for the proper carrying out of such a law congress frame certain clear directions for the treatment of railway accounts, and, with a view to preventing manipulation for stock-jobbing purposes, attach a heavy penalty to any violation of this law.

As regards the internal working of the corporations, railway and other, of course much of the value of the above recommendations must depend upon the ability and honesty of the auditors. Perhaps nothing seems so peculiar to American ideas as the influence which the reports of British accountants possess. In this country, where the word *expert* bookkeeper is too often supposed to be the full equivalent of the London public accountant or the chartered accountant of Scotland, it is unintelligible that there should exist a class of carefully-trained professional accountants, whose word is law on all questions of accounts, and who care no more for the opinions of railway presidents on such subjects than they do for that of the least important member of their office. These accountants serve fully as long an apprenticeship to accountancy as the law student does to law, and the final examination before admission is still more strict, because the accountant must be familiar with all questions of law relating to accounts, as well as with the science of accountancy. So high is the standing of the well-known accountants in London that all the great capitalizations there—frequently involving millions of pounds—are made solely on their reports, and no one ever dreams of questioning them.

In the Companies Acts perhaps no provision is more important than that which gives the stockholders access to the share registers.

Where the objective point of the directors' aims is the securing and retaining of a majority of the stock, it will readily be seen that it is a matter of prime importance with them to conceal as much as possible the names and addresses of their copartners in the company and so to avoid combinations; and thus it is that the transfer-books of a company here have a double value compared with what they have in Great Britain, and this possession means frequently the ownership of the key to the situation.

This access to names and addresses of stockholders has indirectly a very wide influence, too, in educating the public to the merits of corporation or joint-stock enterprise. Bankers, promoters, and houses of issue generally, which are engaged in the bringing-out of companies, follow up these lists very closely, and there are many firms in London to-day which have hundreds of thousands of names and ad-

dresses of investors, corrected up to date and classified. By the issue of prospectuses, which is going on all the time, excepting during periods of crises, people are gradually educated in corporation matters, so that they can form a fair idea for themselves of the merits of the scheme before them, first by the names of the directors and officials on the prospectus, and then by the character, locality, and reputation of the investment. Everything on the prospectus has a bearing on their judgment; for instance, the name of the house of issue, the names of the auditors, attorneys, valuers, and bankers,—all are closely scrutinized, for all have their special standing, which is known more or less to the intending investors. During an experience of fifty years the issued prospectuses have become a species of British literature, and, as the same names appear again and again, they come in time to have a value which is known to all with a fair degree of accuracy.

Notwithstanding the rigid requirements of the English Companies Acts, there is nothing harassing or inquisitorial in the character of the legislation in its bearing upon *bonâ fide* corporations. Within the limits of the acts named something is still possible for a dishonest promoter, but, on the other hand, the company itself is held to a strict accountability, and no majority can keep the minority from access to the books when a reasonable ground for inspection exists; nor could a majority long defy a minority which has access to the addresses of the general stockholders. But, indeed, the majority scarcely exists in Great Britain in the form that it is known here. The shares of a company offered to the public at large are widely subscribed, and in the majority of cases taken by from one to two thousand people. There are very few large stockholders, unless where the vendor of the property purchased has taken a block of stock in part payment, and, in his case, steps are taken to prevent that interest from unduly swaying the control.

The result of this wholesale education of the people is that to-day the smallest capitalist as well as the largest can find to his satisfaction just the kind of security he wants, with the further comfort of knowing that it is honestly managed. This kind of investment is less troublesome to him than the collection of house-rents or the worry and responsibility of some independent business, should he, like his American cousin, have embarked in a trade outside his own.

I think that the time will come, and possibly before long, when our people will call for such investments, and, if their cry is responded to by honest houses of issue placing sound and profitable investments before them, the gain to both will be large. Common honesty and the confidence it begets should be very profitable at the present time, and especially to those handling corporation stocks—it is so rare!

THE ABSENCE OF FACTS ABOUT THE NICARAGUA CANAL.

By Charles B. Going.

NO recent development in national affairs is more significant than the awakened interest of our country in events and developments outside of our own geographical boundaries, and no true American but will rejoice to see his country assuming its proper influence among the great nations; but it is most unfortunate that party leaders and private promoters have been as quick as usual to seize upon a confusion between patriotism and blind expansion, and to confirm it by catchy shibboleths.

"I believe in the Nicaragua canal" is chanted vociferously by press and public, legislators and voters, leaders and led, as the first article of a new national creed, accepted in the vast majority of cases on that blind faith which the old theologians considered the proper attitude of the laity toward any formulated belief.

There is neither sound patriotism nor sane business sense in granting the national endorsement to an undertaking of this character on the basis of emotional excitement.

Before undertaking to cope with natural laws and physical facts in engineering construction, to our faith we must add knowledge. The project which we are asked to father is primarily a plain industrial enterprise based on engineering possibilities, magnificent in its proportions, it is true, but essentially similar to schemes laid before capitalists every day. It is not the province of this article to discuss the political or economic aspects of the question; the first and most important point is feasibility, which is a matter of simple evidence; until this is determined, no sound conviction with regard to the enterprise can be entertained.

The proposal which is brought before congress is that the people of the United States shall guarantee the bonds of the Nicaragua Canal Company to the extent of one hundred million dollars. We are invited to take a mortgage on a piece of property the existence of which is as yet projected only, and which will be almost wholly valueless unless successfully completed; and, while the nominal measure of our guarantee is one hundred millions, every one with ordinary experience or observation knows that, once committed to that extent, we should have to back the undertaking, without limit or reserve, to a triumphant conclusion or a miserable fiasco.

Enough is known of the topographical and climatic conditions to be encountered to suggest the magnitude of the problems involved. The work is in many respects without precedent or parallel. Surely, petitioners for such liberal support should show something more than even the most exalted faith or the most perfect intentions, and should justify their plea by the submission of so complete and accurate maps, plans, specifications, estimates, and data of geographical, topographical, and meteorological surveys that no important feature of the project could remain in obscurity, and no reasonable doubt exist as to its feasibility—from the engineer's point of view, at least.

The volume of evidence, however, without which no promoter would go before a body of capitalists and ask for one per cent. of the financial support here solicited, if existent, is absolutely unobtainable. It can not be procured from the Nicaragua Canal Company, and, when produced, may call out enthusiastic support of the canal project ; it may suggest material modification, or may demand entire condemnation of the plan ; but, until it is secured and submitted, in the name of reason let us call a halt and keep the treasury closed.

The propagandists of the canal enterprise, however, are princes in enthusiasm and paupers in facts.

The facts, indeed, are so curiously inaccessible that it is hardly possible to obtain them except in the report prepared by the board of engineers appointed, pursuant to a provision in the act of congress approved March 2, 1895, " for the purpose of ascertaining the feasibility, permanence, and cost of construction and completion of the Nicaragua canal by the route contemplated."

Of this report it would be impossible to speak too highly. Indeed, the names of Lt. Col. William Ludlow, Civil Engineer Mordecai T. Endicott, U. S. N., and Mr. Alfred Noble are of themselves sufficient guarantee of masterly work ; but even a reader wholly unfamiliar with the professional standing of the board members must be at once profoundly impressed with the thorough, able, and conscientious conduct of the examination, and the clear and systematic presentation of the results.

It is in the highest degree unfortunate that the edition of the report was so inexplicably limited that hardly a copy can by any means be procured by a private citizen. The board members were appointed as representatives of the people, to obtain all existing facts and information with regard to the property which the people are practically solicited to buy. It remains for those interested to explain why the result of the investigation is so sedulously withheld from the knowledge or inspection of those in whose very interest it was prepared.

The commissioners spent the entire time from May 7 to June 24

on the line of the proposed work, examining the ground and collecting all the data and evidence procurable from the company or from their own observations. From June 24 to July 21 they were engaged along the line of the Costa Rica Railroad and the Panama canal, examining these properties with a view of determining the effect of local and climatic conditions on constructions similar to the one proposed.

From that date until the time fixed for the submission of the report (Nov. 1), they were continuously occupied in New York in a "full and careful investigation of the company's records and data."

They express their appreciation of the fact that "the records have been placed freely and fully at the board's disposal, and every facility given for their examination." The sum of their knowledge, therefore, is the entire fund of facts compiled or observed, and of plans prepared by the company. The measure of their ignorance is coextensive with the defects and deficiencies of the company's information, except so far as the board's own observations have supplemented those of the company and reduced the great mass of existing ignorance.

This point is important; for the company, being apparently disappointed with the report, attempts to weaken it by alleging a lack of knowledge on the part of the board. In so far as such lack exists (and the board repeatedly deplores the meager information at its disposal), it merely testifies to the woeful neglect of the Nicaragua Canal Company.

The projected construction contemplates at the outset the improvement of Greytown harbor. From this point the canal is to stretch westward at sea-level to the eastern divide, the crossing of which is effected in part by three locks raising the canal level, and in part by an enormous cut 3.15 miles long and 324 feet maximum depth.

Emerging from the gigantic "east divide cut," the route traverses a series of deep basins, which are to be confined by dams and joined by short excavated canal sections through the intervening ridges. The closing of these "San Francisco basins" will require sixty-seven embankments, with a total crest length of about six miles, and heights varying from a few feet only to seventy feet and upward.

At the end of this stretch, the canal is to emerge into the San Juan river, which is at present far below the proposed summit level. The Ochoa dam, projected here, would raise the surface of the river approximately sixty feet above present low water, and, of course, flood the valley back to the lake, sixty-nine miles distant. The dam itself would have a total height of about 105 feet, abutments of 650 feet, and a 1250-foot weir on the crest to discharge surplus water. Incidental to it would be twenty-three minor embankments.

Above the Ochoa dam the canal is to follow the river, which must

be deepened in the upper part, and a channel must also be dredged for fourteen miles through the soft mud of the lake.

Thence the course will be across the lake, up the valley of the Lajas to the western divide, which is crossed by a 74-foot cut, and thence down the valley of the Rio Grande to the ocean at Brito. The crossing of the torrential Tola would be avoided, in the favored plan, by the construction of the La Flor dam, with a crest length of 2,000 feet and a height of 90 feet, confining both Tola and Rio Grande in one basin level with Lake Nicaragua. From this, locks would descend to tide-level.

Even this very brief outline will make immediately apparent the magnitude of the dam and embankment work projected by the company, and the enormous extent to which it must be affected by conditions of rainfall. It is not merely a question of the preservation of dams, cuts, and embankments, however, serious though that might seem in view of the board's report that "there is a rainfall record at Greytown for the years 1890, 1891, and 1892 which shows a mean of 267 inches, a maximum of 297, and a minimum of 214," and also that "there is reliable information of precipitations of 3 inches in an hour, of 9 inches in 9 hours, and 35½ inches in 8 days."

When it is considered that the average yearly rainfall is about four times that in the rainy belt of the United States, and the nine-hour precipitation equal in volume to that which caused the Johnstown flood and from two to four times as rapid, the problem of construction and maintenance under such conditions seems serious enough. But, more than that, the maintenance of the entire summit level of one hundred and fifty-three miles within the narrow limits between water too low for navigation, on the one hand, and too high for the safety of the work, on the other, must depend on an accurate knowledge of every detail of rainfall and watershed, including the accurate gaging of every stream involved.

It is, therefore, with astonishment that we read that the observations with respect to rainfall are "scattering and unsatisfactory"; that "the company has omitted attention to this matter, and made no careful gagings at any point"; that, although "the most serious problems affecting the design and construction of a canal system at the present time are those involved in the heavy rainfall and consequent discharge from the lake and streams whose variation of surface and volume must be taken into account," yet "on these points the existing data are seriously defective both in respect of number and continuity"; that, while "the height, cross-section, and volume of cuts, dams, and embankments, and the dimensions of locks, weirs, and sluices to be constructed for the maintenance and utilization of the summit level, the precautions

to be taken to make these works secure, and the loss in elevation of water surface due to drought or deficiency, all these depend for their determination upon the fullest and most precise gagings of all the watercourses concerned, ... this information has not been secured."

Truly, as the board temperately remarks, "this omission is the more to be regretted because the company's project calls for the construction of numerous dams and embankments of magnitude, some of them without precedent in engineering practice, and all involving serious hydraulic problems."

Following such a startling revelation of wholly inadequate knowledge, it is less of a shock to discover that, at the very first point of any difficulty west of Greytown,—that is, the crossing of the Benard Lagoon,—"the bed is *supposed* to be mud of great depth," in which the building of banks would be very difficult; or to learn that the plan contemplates the diversion of the Deseado river just west of Lock No. 1, although "the flood discharge of the stream is not known"; or that an important dam has been planned near Lock No. 3, although "no borings have been taken at this site, and it is not known whether a suitable foundation for a concrete dam can be found."

Indeed, we are now ready to hear that "the canal company has no detailed plans of the locks and other structures for which its estimates are made, and the board has had to prepare preliminary drawings for the lock estimates."

But the central divide cut—the next feature of the canal, and by far the most expensive single item of the work—is an undertaking so colossal that it is inconceivable that any important plans should be based upon it, or any estimates made for it, without a thorough knowledge of the conditions to be encountered in its construction. The only investigation made by the company, however, was a pitiably scanty series of borings "along the center line of the canal at intervals of 1,000 feet, with a diamond drill, obtaining cores of the rock passed through. "These cores, arranged in order, would be a valuable record, but only a few samples from a small number of the borings have been preserved. These samples, with the scanty notes turned in by the chief of the boring party, and such examination of the outcrops as the board was able to make during the inspection of the route, constitute all the information now available." "New borings . . . . are indispensable."

It must be borne in mind that the company's proposed cut, at a slope of one horizontal to five vertical, would have sides so closely approaching the perpendicular that they could not be maintained, except in rock of the soundest texture. That such rock will be found through-

out, the board considers extremely improbable; indeed, it thinks the conclusion seems inevitable that "flatter slopes than those assumed by the company will be required at the outset," but it can only dismiss the subject by saying: "the board regrets exceedingly that it is compelled to present so inadequate a discussion of the east divide cut, the most costly section of the whole project; but the data at hand are so scanty and defective that no satisfactory treatment of the subject is possible."

The next section of the canal—the San Francisco basins—is considered by the projectors* "the weakest feature in the whole route." The embankments forming these basins, as already stated, are to be sixty-seven in number. The longest will be 1.2 miles in crest length, with a maximum height of 85 feet. "At least four of these larger dams will have a height of 100 feet above their foundations"; yet so defective are the investigations that, while "the company's borings in the beds of the Danta and Nicholson sank through thirty feet of soft mud before reaching clay," "there are two of these swamps of similar character that have not been investigated, and whose depth of mud is not known"; and, although (as first planned) "all these embankments will be, in fact, so many waste weirs for the discharge of the surplus water at several points in the basin," "it is not clear for what amount of drainage, or for what area, these weirs are intended to provide, as the streams in question have not been gaged in flood nor their watersheds measured."

By more recent modification of the plans, the dams will be relieved of the dangerous duty of acting as weirs, and provision for this purpose made by sluice openings in the adjoining hill crest; but the criticism as to ignorance of the conditions still stands. Furthermore, while it is proposed to introduce a guard gate in this stretch of the canal, "there are no drawings nor plans for these gates."

The great Ochoa Dam, however, the "main prop of the company's project," the proposed structure which "has no precedent in engineering construction," we can hardly conceive to have been planned in ignorance of any, even the smallest, detail which could affect the erection or preservation.

"A failure here would leave navigation stranded, wreck the valley below, and wash Greytown into the sea." It must be remembered also that the dam is not only to impound the waters of the San Juan and San Carlos rivers: it is also to hold the entire lake from falling below the lowest permissible level, and to extend the summit level eastward through the basins and the divide cut to Lock No. 3.

The actual extent to which blind confidence has been allowed to usurp the place of sound and sufficient knowledge can again best be

* Mr. Menocal's paper, Chicago, 1893.

presented in the words of the board. "It is important to know: (1) what is the nature of the river-bed and banks upon and between which the dam is to be built; (2) what are the physics of the stream itself, its range between high- and low-water stages, its varying slopes, velocity, and volume, the magnitude, duration, and frequency of its floods. Unfortunately, information of this kind is seriously deficient. The company's surveys are mainly devoted to topography, and did not include the collection of hydraulic data."

"The geological investigation was both scanty and unsatisfactory."

"The (company's) party was provided merely with earth augers for boring into clay, and with pipes and sand-pumps for exploring the sandy bed, but had no drills for testing rock, if found, to ascertain its character and quantity."

"More precise data as to the extent of the floods are necessary, before the dimensions of the weirs and sluices can be fixed." "No survey was made of the river, and but one gaging, and that of no present value, as the stage of the river when it was made is not known." "The river has never been gaged at a flood stage." In other words, the company seems to have projected a dam on guess-work, and the board does not consider the guess a good one. Perhaps, therefore, it is no great matter that "the company has no detailed plans or specifications for the dam," difficult though it may be to reconcile this with the preparation by the company of total estimates for the whole canal.

But, granting, for the time being, the entire practicability of the dam, and its sufficiency to withstand the severest floods, would it retain a sufficient depth of water in the river and lake during the dry season? To quote the board again, "the regulation of the lake itself offers difficulty, and the matter is so important, and has been so completely overlooked," that "there is hardly any definite information as to the amount of water received by the lake during the dry season." "The amount of water to be dealt with, either during the year or during floods, is unknown. The annual rainfall is not known at any point between Ochoa and the west shore of the lake."

"It is to be regretted that the canal company has no recorded observations of the lake level, or other data relating to its regulation for the eight years since it began work in the country. The matter is of such vital importance that observations ought to have been made continuously during the entire period." "The whole problem of the regulation of the summit level . . . . and even the practicability of the company's project . . . . requires the collection of a large amount of information, before it can be solved."

Proceeding up the San Juan river to the point of proposed improvement, the board finds "no means of ascertaining, with any ap-

proach to accuracy, what may be the quantities and proportions of the materials to be removed, whatever may be the cross-section."

"It appears that the company has made no surveys or examinations of the sixty-nine miles of the river between Ochoa and the lake, with the exception of a partial survey by compass, which is laid aside as valueless." "The profile furnished by the company is little more than guess-work." "The omission of the company to determine these (facts) seems inexplicable." It does, indeed.

Passing rapidly over the lake without further criticism than a question as to the sufficiency of the company's dredging project, there remains only the comparatively short canal work between the lake and the Pacific: but here again, although it is proposed to dam the torrential Tola river, "unfortunately, it has not been gaged, and even its drainage area is not known."

On the site where the dam is projected, diamond-drill borings penetrated 338 feet below the surface of the ground without encountering any solid material, but, in spite of such serious discouragement, "the company is unwilling to abandon the idea of the dam."

As to the remaining part of the route it remains only to say that borings at the site of the proposed tide-lock "show a deposit of mud of unknown depth, extending at least thirty-seven feet below lock-bottom," and that, for the difficult problem of making a safe harbor of the open roadstead at Brito, "the information available is not sufficient to enable final plans and estimates to be made. The borings made under the company's direction are too few in number and of too little penetration to determine the underlying materials within the harbor limits." Such is the incredible amount of ignorance with which the company's project is invested; in spite of which, they present a grave estimate of cost, placing it at $66,466,880 by the Tola basin line, or $69,893,660 by the low-level line.

The board's idea is that the work, if practicable at all, will require an outlay of $133,472,893*; but, unlike the company, it carefully directs attention to the impossibility of making more than a vague approximation to cost. Even if the most careful determination be made of unit prices (and it does not appear that it has been) yet "it must be noted, however, that the company has made no final details or construction drawings, so far as is known, and general data are relied upon for computing cost. The only specifications drafted are those for the dredging work, and the particulars as to this are in some cases lacking in definiteness."

No space has been given in this article to the serious criticism

* It is reported that Col. Ludlow, when under examination by the house committee, expressed regret that the estimate had not been made $150,000,000.

passed by the board upon many important points of the company's project. The aim of the review is solely to make apparent the chaotic uncertainty of this imperfectly-considered and ill-assured scheme, for which the company asks the endorsement of the United States to the initial extent and nominal limit of one hundred millions of dollars, but practically to an amount which, unless the people are better advised than the company apparently wishes them to be, can only be conjectured by considering the experiences of French investors with the Panama canal. The security for this magnificent mortgage is to be, not a property, but a project; the argument for its success rests, not upon sound engineering investigation, but upon possibly brilliant, but certainly unreasoning and so far unsupported, faith; and the din of spread-eagle oratorical appeal to national self-confidence covers up the dark and mysterious silence as to physical facts.

When it is further noted that the report containing the facts is limited to so small an edition that a copy is almost unprocurable, and that, even if a copy be obtained, it will be found destitute of the twelve appendices and thirty-four maps and charts which are replete with interesting information and would make the whole clearly and immediately intelligible, it seems impossible to escape the conclusion that it is not desired that the facts should be known.

Until they are known, the attitude of every intelligent citizen should be an open mind and a close pocket,—most of all, if he be a friend of the canal. Refusal of financial backing now has no relation to ultimate conclusions regarding the enterprise. It may be not only feasible, but desirable from every point of view, but this can not possibly be determined until, as recommended by the board, at least eighteen months' time and three hundred and fifty thousand dollars have been expended in making the investigations which the company should have completed long since, but has entirely neglected.

It is understood that the rehabilitated Panama canal enterprise, profiting by bitter experience, will incur an expenditure of over one million dollars in exhaustive studies, and that it is the intention to submit all the resultant data to an international engineering board of the highest standing.

Until we follow this example, at least to the limited extent recommended by the board, an espousal of the present Nicaragua canal scheme would be more than fatuous business policy. It would be imperiling the national honor, and perhaps inviting a national shame.

RELATIONS OF ELECTRICAL AND MECHANICAL ENGINEERING.

By Elias E. Ries.

WITH the rapid march of new discoveries and inventions in science and the mechanic arts, such as has especially characterized the latter half of the present century, and the consequent increase in the application of new principles and improved methods to nearly every branch of material progress, it is not strange that, as new industries are created and the sphere of existing applications of physical and mechanical principles is widened, general engineering practice should become more and more specialized. This process of specialization has, in fact, been followed to such an extent in the science of engineering as to have gradually given rise, in many well-defined instances, to entirely new and distinct professions, having little or nothing in common with those that preceded them, except in the elementary particular of being based upon the practical utilization of certain natural principles and laws.

Engineering as a science or profession was originally applied to military operations, and was subsequently divided into two branches, designated as "civil engineering" and "military engineering." Since then the science has undergone a wonderful extension and growth, and at the present time the term is applied broadly to the planning and erection of such works and structures as involve a comprehension of mechanical and physical laws.

Nor does the modern use of the term "engineering" restrict it to the design and construction of work in which ordinary mechanical effects are the sole objects. We have to-day, for example, architectural engineering as distinguished from architecture as a fine art. So, also, the calculation and laying-out of a system or network of main and distributing conductors designed for the transmission and distribution of electrical energy, even though all the energy to be transmitted be directly converted into heat without the intervention of mechanical motion, falls entirely within the scope of engineering practice, and demands a degree of skill easily comparable to that involved in the projection of a steam railroad.

The process of specialization in the profession of engineering, due to the development in the mechanic arts, has opened many continually-widening fields for the exercise of engineering skill, each demanding more and more the exclusive time and attention of the engineer

who has identified himself with and made a study of its special opportunities and requirements. The most recent of the important special additions to this constructive science is electrical engineering, and it is to the evolution and development of this science, and its relation to mechanical engineering, to which, owing to its general character and scope, it is most closely allied, that we now propose to give attention.

The relations that exist between mechanical and electrical engineering are, in more than one respect, exceedingly close, and the question of their mutual dependence has formed the subject of much discussion. Some have gone so far as to assert even that the profession of electrical engineering must eventually be absorbed by mechanical engineering, although it is scarcely necessary to say that this extreme view cannot for a moment be entertained, and that those who hold it have taken an exceedingly narrow view of the field which electrical engineering claims exclusively. Neither can it be said that electrical engineering, in its most comprehensive sense, will ever absorb the profession of mechanical engineering,—an opinion that is likewise held by probably a much larger number of those engaged in mechanical pursuits, who look with amazement upon the rapid inroads that this younger and more vigorous branch of applied science is making in many directions heretofore regarded as within the exclusive province of the mechanical designer and constructor.

It is only within the past few years that the profession of electrical engineering, as such, has had any existence. Prior to the invention and commercial introduction of the incandescent electric light, and more recently of the electric motor, there was practically no work calling for the exercise of what is now understood as electrical engineering, if we except the somewhat restricted profession of the telegraph engineer. The proper design and construction of dynamos; the planning and erection of central stations; the projection and laying-out of systems of electrical distribution; the building and equipment of electric railways; the intricate problems involved in the installation and economical operation of large electric power generation and transmission plants,—all of which to-day call for mathematical, constructive, and engineering talent of a high order,—were then unknown.

Previous to this later activity in the electrical field, in the days when the electric telegraph was almost its sole occupant, the title of "electrician" was recognized as representing a distinguished profession which embraced the highest attainments in the line of electrical practice and theory. An electrician in those days was looked up to with a feeling akin to awe and superstition by his contemporaries in other branches of mechanical work and by the general public. The marvels of the quadruplex and the ability to locate, by means of the

Wheatstone bridge and the galvanometer, the exact position of a break or "leak" in a cable buried in mid-ocean seemed not the least of the astonishing features of the electrician's art, and very justly so.

Less than twenty years ago the practical applications of electrical science were limited chiefly to the telegraph and the district-messenger service, to electrolytic processes, and to minor industrial and domestic purposes, to which the comparatively weak battery and magneto currents which then formed the only readily-available source of electrical energy easily lent themselves. Most of these earlier applications of the electric current, while coming within the sphere of the electrician's work, required less of mechanical skill than of inventive ingenuity in adapting them to the various purposes which they served, and, in the case of the more complicated apparatus, the presence of a convenient instrument-maker supplied any deficiency in mechanical knowledge on the part of the electrical experimenter.

From this time on, however, the duties of the electrician gradually embraced a wider and more responsible field of work, which called for the creation and exercise of additional knowledge and skill as the later branches of dynamic electricity presented more novel and important problems for his solution. These newer and more exacting duties of the electrician, and the remarkable results that bore testimony to his mastery of hitherto unknown electrical and electro-magnetic laws, materially aided his advancement, and caused him to assume an even higher place in the eyes of his contemporaries than he occupied in the earlier days of the telegraph.

Since the commercial advent of the dynamo-electric machine and the consequent cheaper production of electrical energy in large units, followed by its speedy utilization in the form of light and power, the profession of the electrician has by degrees expanded so as to include that of the mechanic and engineer. The practical electrician of former times, who was fully qualified in the application of Ohm's law to the measurement of resistances and to the electrical testing of batteries and circuits, seemed to be, in the majority of cases, quite incapable of developing the mechanical constructive ability needed in the newer and heavier work which the generation and commercial application of these more powerful electric currents have called into existence.

It was during the early days of this period of activity, and in the practical but expensive school of experience, that the evolution of the electrical engineer commenced. Although his path was beset with difficulties, he eventually proved himself equal to the emergency, and in due time became thoroughly acclimated to his new environments. Not until 1884, however, did the new profession of electrical engineering receive substantial recognition as such, by the organization,

on May 13 of that year, in New York city, of the American Institute of Electrical Engineers, to which institution and the valuable papers brought before it by its members, who now number something over one thousand, is due not a small share of credit for the gigantic strides that have been made in electrical engineering, as well as in general electrical science, during the past decade. Nor was it until some years later, when the installation of electric lighting and power stations throughout the country, followed by the experimental operation of a number of lines of electric railway, had demonstrated the pressing need for educated electricians possessing a combined electrical and mechanical training, that the course of electrical engineering was placed upon the curriculum of our colleges and universities. The first educational institution to adopt this course of advanced electrical instruction leading to the degree of "Electrical Engineer" was Columbia College of New York in the year 1889, since which time special attention has been given to practical instruction in electrical engineering by most of the prominent universities and by many technical schools in this country and in Europe.

Prior to the advent of the electric motor and its applications to mechanical and manufacturing industries, mechanical engineering was supreme in its command of the entire range of mechanical design and construction as applied to technical work. The education of the mechanical engineer was considered sufficiently complete, if he possessed a thorough knowledge of the laws of motion and of the principles of mechanical and other simple physical forces, such as hydrostatics, pneumatics, and heat; if he was familiar with the theory and construction of the steam boiler and engine, and with the principles of mechanical drawing and machine design; and if he had enough mathematical training to enable him to figure out the strength and proper proportion of the materials needed in the different portions of his work. This, with a certain amount of practical experience in machine construction and a general study of applied mechanics, was ample to enable him, if he possessed a reasonable degree of originality, to cope with any problem that might confront him in his professional career.

There is still, of course, and always will be, an enormously large field for the profitable exercise of a thorough mechanical training such as this. But, in view of the growing use of the dynamo and electric motor in manufacturing establishments and in modern machine-shop practice, in which they are now either supplanting or supplementing the steam boiler and engine (to say nothing of the increasing use of electricity in other technical and industrial processes), the up-to-date mechanical engineer must familiarize himself, if not with the fundamental principles of electrical science and the elements of electrical and

electro-magnetic calculations and measurements, at least with the mechanical design, construction, operation, and control of the dynamo and motor and its general applications, in so far as the same may be useful to him in determining to what extent and in what connection the employment of electrical energy as a motive or controlling force may best be used in his construction work and other problems arising in his daily practice. Electrical applications, in fact, are so rapidly assuming an important place in nearly every department of engineering that an *elementary* knowledge of the science and its various uses in connection with his special department is to-day an essential requirement of every engineer, and particularly of the mechanical engineer.

It may be said, however, that, in this inventive and constructive age, the field of purely mechanical engineering and design will always remain so large, and form so great a proportion of our material progress, that, instead of diminishing, the work of the every-day mechanical engineer will continually increase, being, in fact, enhanced by the competitive activity in the electrical field ; and that he will, therefore, find enough to do in his particular specialty without attempting to master the more difficult technicalities and daily increasing problems that confront the electrician and electrical engineer, which properly belong to an entirely different branch of physics and demand an entirely different treatment from that falling within the ordinary and most efficient training of the mechanician and mechanical engineer.

Owing to the misconception that popularly prevails regarding the distinction to be drawn between the occupation or calling of the electrician and that of the electrical engineer, the two vocations being frequently looked upon as identical, it may be well to define this difference before proceeding to investigate the duties of the electrical engineer and the relations between him and his mechanical brother.

The electrician bears very nearly the same relation to the electrical engineer that the mechanician does to the mechanical engineer. The modern electrician should possess a thorough knowledge of physical as well as electrical science. He must have made a complete study of all electro-static, electro-magnetic, and electro-dynamic phenomena known to the science, especially those that have a bearing upon his special work, and must be familiar with the laws governing the same and with their practical application. He must understand electrical testing and measurements, and be familiar with the use of instruments employed in connection therewith, and with the use of algebraic formulæ. His theoretical and practical training may be, and frequently is, of an exceedingly broad character, depending upon the range of experimental and practical work to which he applies himself. It sometimes covers the entire range of electrical invention and

experimentation, but more often is confined to some particular line or lines to which he devotes special attention.

Although the vocation of the electrician does not in itself demand a comprehension of mechanics in its practical sense, yet a theoretical understanding of mechanical principles is more or less essential to, and is usually possessed by, him, especially if he is of an original or inventive turn of mind. As a rule, however, the function of the electrician does not extend into the domain of mechanical, or of engineering, practice, as does that of the electrical engineer. In the exercise of his duties he may be said to occupy an intermediate place between pure theory and advanced practice, in the application of electrical principles to various scientific and technical uses as well as to the minor commercial and industrial purposes that do not call for the exercise of engineering skill.

In order that the status of the electrician may not be misunderstood, it may be remarked that the advanced electrician who keeps himself in close touch with modern developments in his science very often has a more comprehensive and exact knowledge of the latest and most desirable practice in any particular branch of the art than the electrical engineer who limits himself to a single branch of electrical engineering, or to a certain type of installation, to such an extent as to be unable to grasp or utilize the advances made in some analogous line of work.

Coming now to the consideration of electrical engineering, we may at the outset divide this profession into two distinct classes, the one analogous to civil engineering and the other to mechanical.

The first class of electrical engineering, which includes also the profession of the "consulting" electrical engineer, embraces the application of electrical laws and principles to the projection, construction, and installation of more or less extensive works, in which electrical energy in one or more of its various forms is to be utilized. Examples of this class of electrical engineering are to be found in the work of devising, calculating, and mapping out systems for the generation, transmission, and distribution of current for electric lighting, heating, and power purposes and in adapting the same to the continually-varying conditions and requirements met in practice.

This class of electrical engineering is, for the most part, selective rather than constructive, but, nevertheless, requires a complete knowledge of the principles of both electrical and mechanical science, and a practical training in the application of these principles to the special class of work in hand. The perception and proper economic application of the laws governing the generation, distribution, and utilization of electrical energy, particularly in the form of alternating currents of

various phases and frequencies, demands a high degree of scientific, mathematical, and engineering proficiency, as any attempt at solution of some of these problems on the part of the novice will demonstrate. As a rule, however, the practical electrical engineer usually works with standard or well-tried formulæ, and is, therefore, not so much concerned with original experimental investigations.

The second class of electrical engineering alluded to, which is the one most closely allied to mechanical engineering, is that which has to do with the practical design and construction of electric generators, motors, transformers, and other electro-mechanical apparatus.

The intelligent and successful practice of this division of electrical engineering, which may be termed the constructive branch, requires by all odds the application of the highest degree of electrical, mathematical, and mechanical skill. Not only is a complete knowledge of mechanics and the principles of machine design requisite, but also a most thorough comprehension of the laws of electro-dynamics, and the ability to apply them successfully to the calculation, design, and construction of the various types of apparatus under consideration, and the proper mechanical adaptation of the same to the special duties required of them. The formulæ for the calculation of current and electro-magnetic induction, particularly in connection with the design and construction of alternating current apparatus, are exceedingly complicated and difficult of application, while the correct proportioning of armature and field coils and the proper subdivision and winding of armatures of certain types of dynamos and motors, however simple the same may finally appear in regular manufacture, is scarcely less difficult when it comes to the precalculation of these various features for a new or special class or size of apparatus.

Among the many kinds of apparatus whose design and construction properly fall within the province of the "electro-mechanical engineer" may be mentioned:

First, electric generators, or machines for the conversion of mechanical into electrical power. These, commonly known as dynamo-electric machines, or simply as dynamos, are of a wide variety in design, appearance, principle of construction, methods of operation and regulation, character of output, and range of work,—so wide, indeed, that it is doubtful whether any other single class of mechanical apparatus presents, in its different applications, such diversification.

Second, electric motors, or machines for the conversion of electrical into mechanical power. This includes not only the design and construction of ordinary electric motors, but their design and adaptation to special classes of direct-connected work, including the design

and construction of the necessary gearing and controlling devices in connection with such work, and the proper installation of the same.

Third, transformers, or machines for converting a current of a given pressure or voltage into one of a lower or higher pressure, or for converting an alternating into a continuous current, or *vice versa*.

In addition to these, there are many other forms of electro-mechanical apparatus that are now coming more and more into use, all of which demand, not only a thorough proficiency in mechanical as well as electrical science, but full conversance with laboratory and machine-shop practice. In short, to be efficient, he must combine the profession of the electrician with that of the mechanical engineer.

The importance of correct mechanical design and construction in electrical-engineering practice cannot be too strongly dwelt upon. In the early stages of this art, examples were not wanting to show how inadequately the need of proper mechanical construction was appreciated, due in a measure, no doubt, to the more pressing elec trical problems with which the pioneers in this field had to contend. The history of the electric-railway industry forms a conspicuous illustration, and one that is doubtless still fresh in the memory of many of the readers of the ENGINEERING MAGAZINE.

It is probably safe to say that the early practical difficulties encountered by many of the electrical pioneers in the magnificent development we now see about us were chiefly due to a failure to adequately appreciate the close relations that exist between electrical and mechanical engineering, and to the necessity they were usually under of entrusting the mechanical execution of their plans to mechanical or engineering experts, who had little or no previous experience with electrical work, were not acquainted with the character of the electrical laws in accordance with which they were expected to build, and were consequently unfamiliar with the intimate relations between the motor and its work, and the important reactions that quickly manifest themselves in the motor, for better or for worse,—usually for worse,—in accordance with the design and operation of its own and its connected mechanism.

Not alone the mechanical, but also the electrical, requirements of dynamos, as well as motors, were at this period but imperfectly understood. To the excellent educational facilities now afforded the young aspirant for electrical-engineering honors, which have lately enabled him to combine with the scientific and technical training of the electrician a more or less thorough practical knowledge of applied mechanics and of machine design, the modern perfection in electrical construction is largely due; and it is a high tribute to the progress in electrical science in recent years, as well as to the intelligence of the

electrical engineer, that at the present time the predetermination of the characteristics of dynamos, motors, and other electro-mechanical apparatus has been reduced to an exact science.

Having now reviewed the manner in which the profession of electrical engineering was developed, and having seen that its present perfection is largely due to mechanical engineering, which is essential to, and in some respects identical with, it, the question may possibly be asked: "Why not remove the dividing line entirely, and combine the two professions as one? Is not the science of electrics, as related to the profession of mechanical engineering, a purely mechanical agency or power in the same sense as pneumatics, hydraulics, heat, steam, and other dynamical forces, and, as such, should it not be studied and utilized by the future mechanical engineer as he would study, select, and utilize any one or more of these other forms of energy in his daily practice, as occasion demanded? And, if so, since engineering is primarily a mechanical profession, why should there be any occasion for the separate existence of the electrical engineer?"

If what has already been said is not sufficient to indicate the only correct answer to these questions, they may be finally disposed of by stating that, like the science and practice of mechanics, the science of electro-dynamics is in itself a distinct and intricate art, and that, while the advanced practitioner in each profession should possess a good theoretical and general knowledge of the other, it is essential that he devote himself to, and make a special study of, the practical details pertaining to his particular sphere of labor, that he may achieve the highest success in his own profession.

The activity in the engineering field is so constantly increasing, owing to new developments, that there is a continual tendency toward further and further specialization and segregation in its several departments, as in other branches of human endeavor.

Electrical engineering, in its broad sense, is as yet a comparatively new art, but, as a profession, it has already grown to occupy so wide a field that it is becoming necessary to subdivide it into special branches, just as to-day the profession of mechanical engineering is also subdivided into steam, hydraulic, pneumatic, sanitary, and other special branches, each practised by mechanical engineers who are proficient in these particular lines and are, therefore, better qualified to keep in touch with, develop, and apply the latest scientific discoveries and the most approved methods and appliances in their particular line of practical work. The profession of electrical engineering has come to stay, and, to judge from the facility with which the new power represented by it is applicable to other arts, it bids fair to eventually take precedence of all other departments of engineering science.

DOMESTIC ARCHITECTURE IN WASHINGTON CITY.

By Glenn Brown.

PETER CHARLES L'ENFANT, who drew the plan of Washington city, and Gen. Washington, who modified and finally adopted it, showed themselves to be men of forethought and breadth, with a true conception of how the capital city of a great republic should be laid out. Washington has the exceptional advantage of having been planned as a large city, in the map authorized by congress in July, 1790, and made in 1791. The first president, who understood the situation clearly, gave close and painstaking personal attention to even the minutest details in reference to the new federal city.

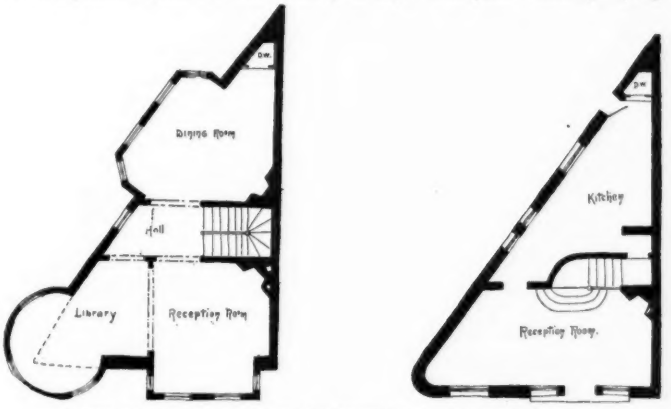
President Washington, L'Enfant, and Ellicott (who was doing the field work) made a thorough investigation of the ground, and, as a note on the map says, "carefully selected the sites of the great edifices where they would command the greatest prospect and be susceptible of the greatest improvement." After these sites were selected, avenues were laid out, radiating from the capitol and president's house, and one or two other important points. This method was adopted, as L'Enfant says, "to preserve through the whole a reciprocity of sight" between the points of interest and beauty in the city. This arrangement, while affording an opportunity for satisfactory views of the government buildings, at the same time furnishes direct access to all parts of the city, and makes the avenues the natural arteries along which traffic and travel find their way.

Commercial and domestic architecture is also necessarily modified by the unusual plan of the city. The wide streets and small triangular, circular, and square parks at intersections of avenues and streets give one a sense of breathing space and at the same time an actual opportunity to see the structures erected on the building line.

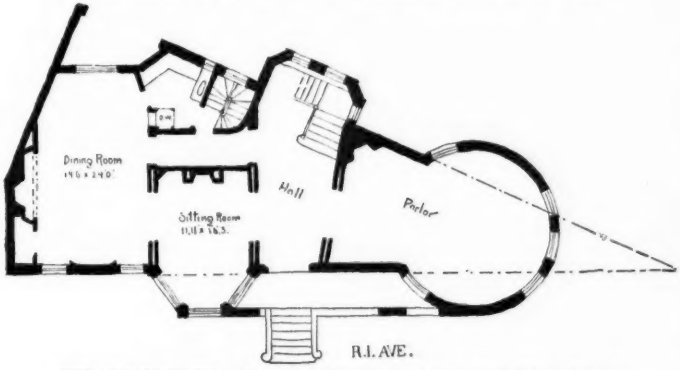
Buildings should be designed here with greater care than is necessary in many cities, as there are always points of sight from which they can be examined and studied, and the good or bad which is in them is especially liable to produce elevating or debasing effects on the taste of the community.

The avenues, cutting across the streets at varying obtuse and acute angles, give great variety to the form of lots, and at the same time give opportunities for picturesque and varied effects in building,

and require ingenuity in the arrangement of interiors. This variety in the form of lots and the right granted by congress to project certain portions of the fronts of structures over the building line on government ground in the form of bay and oriel windows, towers, and porches gives the domestic architecture of Washington a variety, and often a picturesqueness, which are pleasing. The plans accompanying



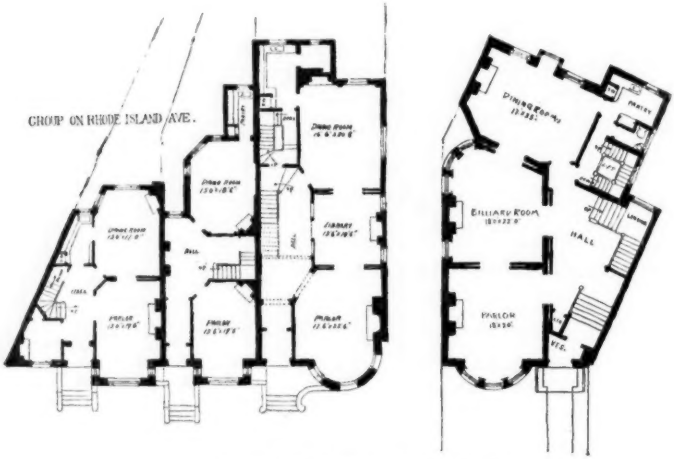
LIEUT. HERWIG'S RESIDENCE; TRIANGULAR LOT WITH WIDE FRONT.



THE SIMPSON HOUSE; ANOTHER TREATMENT OF THE TRIANGULAR LOT.

the text illustrate several varieties of arrangement, and indicate the advantage taken of government ground by the projections on the fronts. It must be remembered that the government owns streets, parks, and parking.

In many parts of the city lots have acute angles formed by the in-



A GROUP OF HOUSES ON IRREGULAR LOTS.

tersection of a street and avenue. Lots of this character allow ample opportunity for light and air on all sides, but usually give very little room for a dwelling. The Simpson house, located on Rhode Island avenue and P street, gives a solution of the problem in which all legal rights to projections have been utilized.

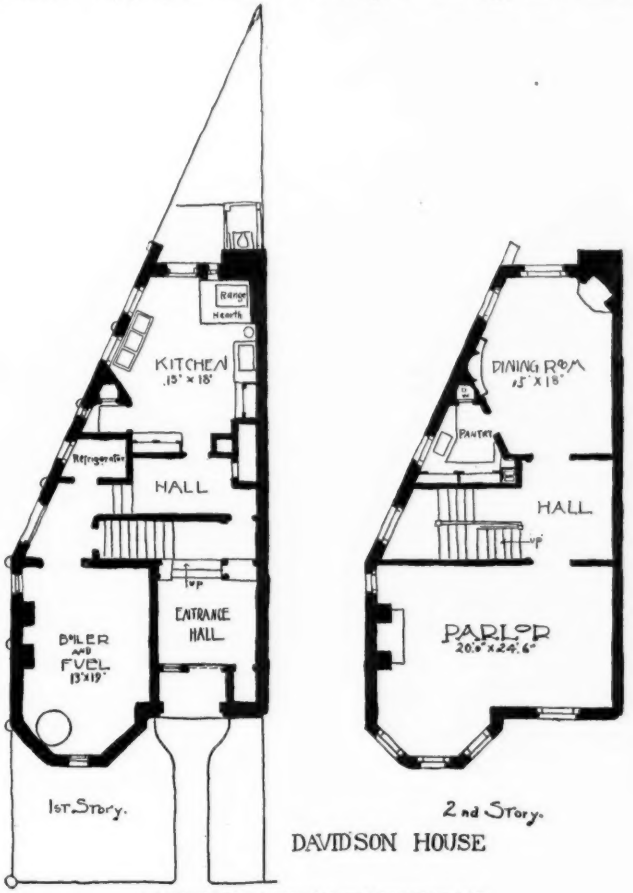
It is a frequent occurrence to find triangular lots with only one side facing the street, and the rear running to a point. The plan of Lieut. Herwig's residence shows how a house has been built on a triangular lot, 26 feet front and 36 feet deep, or on 468 square feet of ground, by taking advantage of the street privileges. The corner one of a group of houses on Rhode Island avenue near Seventeenth street illustrates how this question has been solved where the area of the lot gave greater latitude.

It has been a custom in laying out lots to run the lines, where possible, at right angles to the street fronts; near the intersection of streets and avenues this makes sites of innumerable forms. One with a narrow front and a wide rear is shown in the Rhode Island avenue group, while the Cameron house is located on a lot with lines running in five different directions. The Davidson house gives another scheme for a typical Washington lot.

There are no private residences in Washington equaling the palatial structures so common in many of our large cities. However, the city has homes of dignity and refinement, which have been erected at different periods in its history, from 1800 to the present time. Within

the last ten or fifteen years it has become more and more the custom for people of culture and wealth to have at least a winter residence in the city, and in these residences their ideas as to a home have been interpreted by different architects with more or less skill. Many of these, I think, rank with the best work in the country, when the amount expended in their erection is taken into consideration.

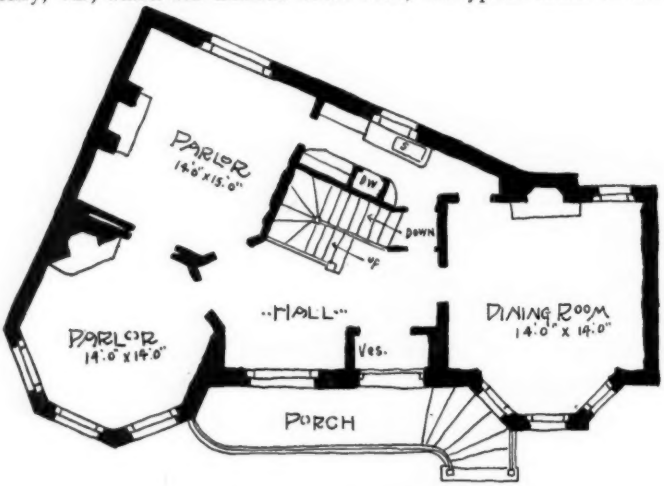
The history of Washington commenced with the establishment of the federal city; by the same act of congress buildings were directed



A SCHEME FOR A TYPICAL WASHINGTON LOT.

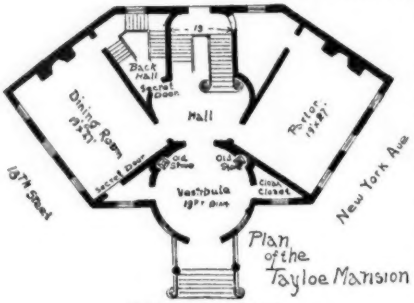
to be ready to accommodate the executive and legislative branches of the government in 1800. The dwellings in Washington at that time were few, and consisted of a small number of houses on Pennsylvania avenue, houses erected on East Capitol street, near the capitol, by the architect, William Thornton, for Gen. Washington, and some detached houses, like Duddington, the residence of Daniel Carroll.

The Octagon house,* the city residence of John Tayloe of Mount Airy, Va., which was finished about 1800, is a typical house of the



PLAN OF FIRST STORY.

A RESIDENCE ON 18TH STREET.



THE OCTAGON HOUSE.

best class belonging to that period. It was designed by William Thornton. The plan shows how one of the first Washington architects solved the problem of irregular sites. The exterior is as dignified, simple, and pleasing today as it was nearly a hundred years ago, when

* Measured drawings, with detailed description, of this house were published in the *American Architect*, January 7, 1888, by the author.

it was the scene of entertainment and fashion. In its rooms all the prominent Americans and foreigners met and were *féted*, and Madison occupied the building after the destruction of the interior of the White House by the British in 1814. The interior is interesting in plan and in the detail of doors which are of mahogany ; also in the mantels, some of which are of cement and others of wood with putty ornament. It is one of the few well-constructed houses of that period, and, although neglected for many years, it is still in an excellent state of preservation.

During the period between 1800 and 1820 Benjamin Latrobe designed several residences,—among them the Van Ness house, built about 1812. Although noted for its situation, surroundings, and entertainments, it does not look as if it could ever have been satisfactory from an architectural standpoint, as the proportions are not good, and the detail is lacking in refinement and the workmanship indifferent. It is probable that the interior, through its furnishing and fixtures, was at one time striking and interesting, but all of this work has been taken away. One of the old marble mantels now in Chamberlain's Hotel, by Thorwaldson, is an excellent example of his work, two figures well-modeled, in repose, making a mantel rarely equaled at the present day. The Tudor house in Georgetown, built about 1818 from the design of William Thornton, has a dignified exterior, but is not equal in refinement to Thornton's earlier work.

The buildings erected between 1825 and 1850 were influenced by the revival of Greek forms in details and porticoes, due probably to the many books on Greek architecture published just prior to and during that period. The details in brick and wood are often very interesting.

About 1850 A. J. Downing, an architect, erected several buildings,—among them the Cook and Dodge residences. These are in what Downing called the Italian Villa style, having large porches, ample projecting cornices, and simple and dignified outlines. These residences have an individuality, a harmony with their surroundings, and a suggestion of hospitality and comfort that are very pleasing.

After 1860 came the mansard roof with monstrous dormers and cornices and every variety of form and grotesqueness that one can imagine ; this continued, with many undesirable productions, until what was called the Queen Anne revival about 1878 or 1879, when gables and towers, hips and valleys, bays and oriels, frequently oddities piled upon oddities, proved refreshing after the monstrosities perpetrated in the name of Mansard. Gray and Page were the most successful architects in the domestic work of that period, erecting many buildings which at the time were thought very attractive ; but these houses did

THE OCTAGON HOUSE, COMPLETED IN 1800.

not have what may be called "staying" qualities. All residences of that period were deficient in repose, refinement of detail, and dignity of *ensemble*, their interest centering in their many oddities. I do not think there is a single example of the Queen Anne period of which one would wish to preserve a record except as a matter of history.

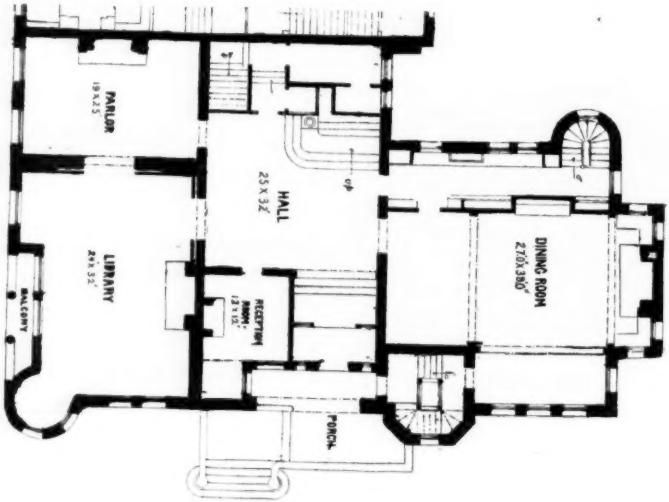
It was while the Queen Anne was at its height that H. H. Richardson's first house, the residence of Gen. Anderson, Sixteenth and K streets, was erected in Washington. It was the first example of what was called Romanesque work in the city. It was so striking in its difference from the prevailing work, with its large, unbroken wall surfaces, small openings, and high, simple, and expansive roof, that it attracted attention and caused comment favorable and adverse. The general verdict—and it is probably correct—has been that the building is too heavy and massive for a private dwelling. Yet it improves upon more intimate acquaintance. The proportions are so good, the massed detail is so effective and refined, the lack of pretension and

show is so evident, that we must look upon this as one of the houses that will be pleasing to future generations.

Richardson, in the few years intervening between the erection of this house and his death in 1886, designed in the same style the Adams and Hay residences, in one group, and the Warder residence on K street. The former houses are not as simple or massive as his first, and are more in harmony with the prevailing idea of private residences. The general outline is not as pleasing as in the Anderson house; neither is the combination in color produced by the red brick and light stone so effective as the simple brick work of the first-mentioned residence. The low basement story of the Adams house is quaint in effect and charming in detail. The large entrance archway lead-

THE ADAMS RESIDENCE; PART OF A GROUP.

THE ADAMS AND HAY RESIDENCES.



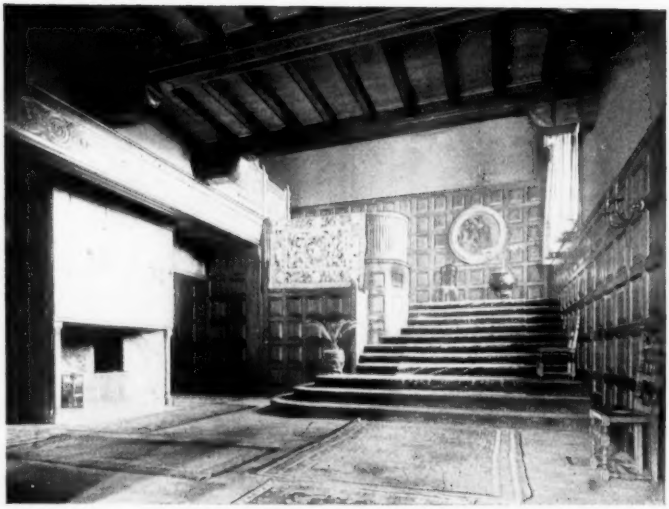
PLAN OF THE HAY RESIDENCE.

ing to the front entrance of the Hay house is very striking and massive,—too massive for the entrance to a private house.

But it is in the interior of these houses that some of their most interesting features are to be found. The halls are very striking in their generous size and quiet, but effective, detail.

The Warder house is in every way the most satisfactory residence, as well as the most satisfactory work by Richardson, in Washington. It is built of light stone with a red-tile roof. The house is L-shaped, giving a garden enclosed by a stone wall. This

DOORWAY OF THE WARDER RESIDENCE.



HALL AND STAIRWAY; RESIDENCE OF JOHN HAY.

PARLOR IN THE WARDER HOUSE.

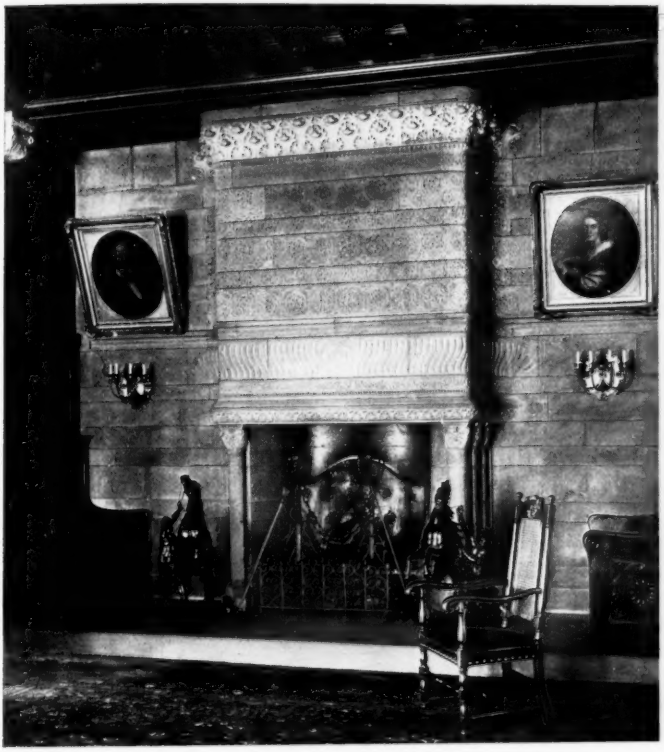
HALL OF THE WARDER RESIDENCE, SHOWING STAIRWAY

DINING ROOM, WARDER RESIDENCE.

form, while giving an appearance of privacy, at the same time affords the occupants an outlook over the garden to the street beyond. The proportions, details, and color are all in harmony, and it is a pleasure to view it as a whole or examine it in detail. The main wall, slightly battered, gives a remarkable appearance of stability, while a slight curve (entasis possibly it might be called) in the quarter tower at the angle, though not noticeable, gives a refinement of outline that is felt. While none of the rooms are large, the hall, dining-room, and parlor are generous in their appearance, and the combination of natural stone, wood, and hangings are all in keeping with each other and most effective. The hall is in dark red oak, with chimney-piece and columns in red stone. The dining-room is in black oak, with Sienna marble fire-place and a

FRONT ENTRANCE UNDER ALCOVE

PLAN OF THE WARDER RESIDENCE.



HALL CHIMNEY PIECE, WARDER HOUSE.

Sienna marble screen between it and the art gallery. The parlor is finished in white holly, with blue satin hangings.

The architectural profession was influenced in Washington, as it was in all parts of the country, by Richardson's work, and for eight or ten years we have had what are called Romanesque buildings, a few good, a large number mediocre, and the majority very bad.

Among the most interesting exteriors in this style is that of the Whittemore house (H. L. Page, architect) on New Hampshire avenue, which is very satisfactory in outline with its high sweeping roof over a simple, low, well-proportioned, and harmoniously-colored building. An old building which the same architect remodelled in the same style for Senator Hearst has some of the most effective detail, both in interior and exterior, to be seen in the city.

THE WARDER RESIDENCE, ON K STREET.

The exterior, as a whole, is lacking in dignity and repose, and the interior is not well adapted for the movement of crowds, although the rooms in themselves, from their size, decoration, and detail, produce the impression of finished productions.

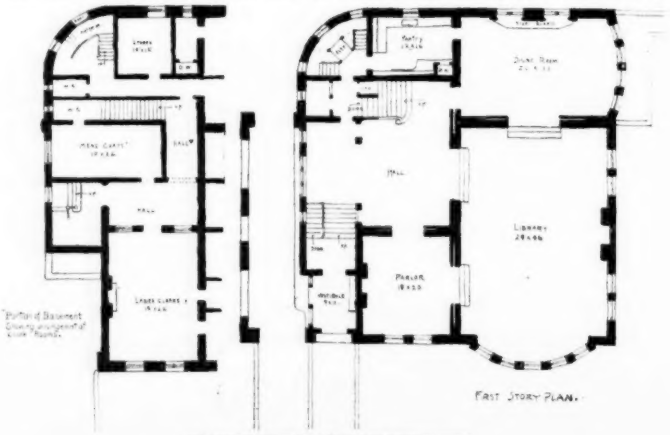
I consider next in importance to the Warder house two residences designed by Hornblower and Marshall,—the Tuckerman and Boardman houses. The first is located directly on the building line, but all the principal rooms are in what would ordinarily be called the rear. In this case it is the garden front, and there is ground sufficient for the effective garden arranged in the rear. The garden front is the most attractive, as it should be. The best should be reserved for intimates. The exterior is simple and dignified, conveying the impression of a comfortable home. The interior is well arranged for entertaining, and for effective vistas through the suites of rooms to the garden beyond them.

The Boardman house is a very massive structure, the exterior of which is built of mottled brick and terra cotta,—solid, substantial, well-proportioned, and destined to stand for years as one of the prominent residences of the city. The details, which show decided classical tendencies, are refined, and in strict subordination to the mass of the structure. The plan shows some novel features.

THE WHITTEMORE RESIDENCE.

DINING ROOM IN SENATOR HEARST'S HOUSE.

The dressing-rooms are in the basement, with separate flights of stairs for the guest passing from the carriage to the dressing-rooms and from the dressing-rooms to the entertaining-rooms. The rooms and hall are very spacious, and the decorations simple, but effective.



PLAN OF THE BOARDMAN RESIDENCE.

THE LIBRARY, BOARDMAN HOUSE.

THE TUCKERMAN RESIDENCE.

THE BOARDMAN RESIDENCE.

DINING ROOM AND HALL, BOARDMAN HOUSE.

LIBRARY MANTEL, BOARDMAN HOUSE.

Houses called Romanesque have been scattered from one end of the city to the other, just as similar houses have been built from one end of the country to the other. Several houses designed by Mr. Wendell in this style, built of white stone, notably the residence of Mr. Carpenter, on Sixteenth street, show both skill and good taste. There are many of this style that fail of being good by the straining after variety and the overloading of detail, with no attention to the mass, among which may be classed the numerous houses designed by Mr. T. F. Schneider.

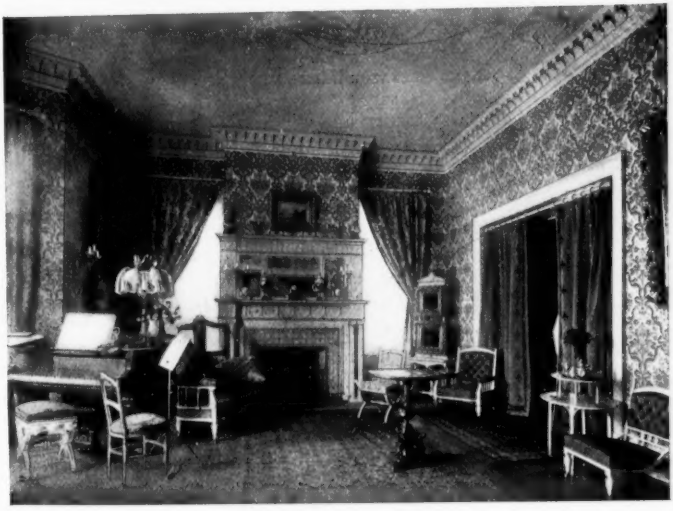
The abominations in the way of ill-proportioned structures with crude and meaningless details are legion, the designer usually contenting himself with several semi-circular arches, and grotesque carvings, as sufficient warrant for the title Romanesque.

About four years ago the old Colonial renaissance made its influence felt in this city, the designers dividing themselves sharply into two classes. One makes an effort to reproduce the Colonial house with archæological accuracy; the other strives to imbibe the spirit of the old work without literally copying any portion of it. The houses belonging to the first class have not reached the point where they merit description, while two of the latter are among the most interesting residences,—Senator Eugene Hale's residence, Sixteenth and K streets, designed by Rotch & Tilden, and the Frazier residence, corner of Twenty-first and R streets, designed by Hornblower & Marshall.

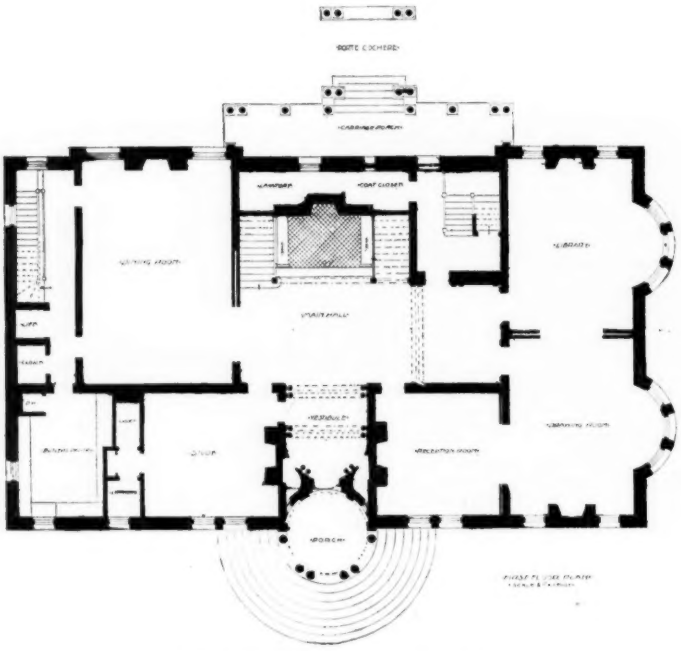
Rotch & Tilden (since Arthur Rotch's death Geo. T. Tilden), in designing the Hale house, gave a broad front on Sixteenth street, the

PLAN OF THE TUCKERMAN HOUSE.

RESIDENCE OF SENATOR HALE.



PARLOR IN SENATOR HALE'S HOUSE.



PLAN OF SENATOR HALE'S RESIDENCE.

only projection being the portico and window balconies. The exterior is of buff brick, with Ohio stone trimmings. The roof is a greenish yellow tile. Although some of the details, which are of course classical, may be criticised, as a whole the exterior ranks as one of the most effective in the city, being dignified, simple, and harmonious in outline and in color. The parking gives the house, although on the building line, the effect of being surrounded by grounds of its own. The arrangement of the interior will be best understood by a study of the plan and interior views.

The Frazier house is a square red-brick structure, the cornice and other ornamental features being in red portage stone and the whole covered by a red-tile roof. The exterior is effective as a whole, and shows refinement when examined in part. The illustration gives an excellent idea of the distance that is obtained by the broad avenues of Washington.

The Leiter house, designed by T. P. Chandler, is another old

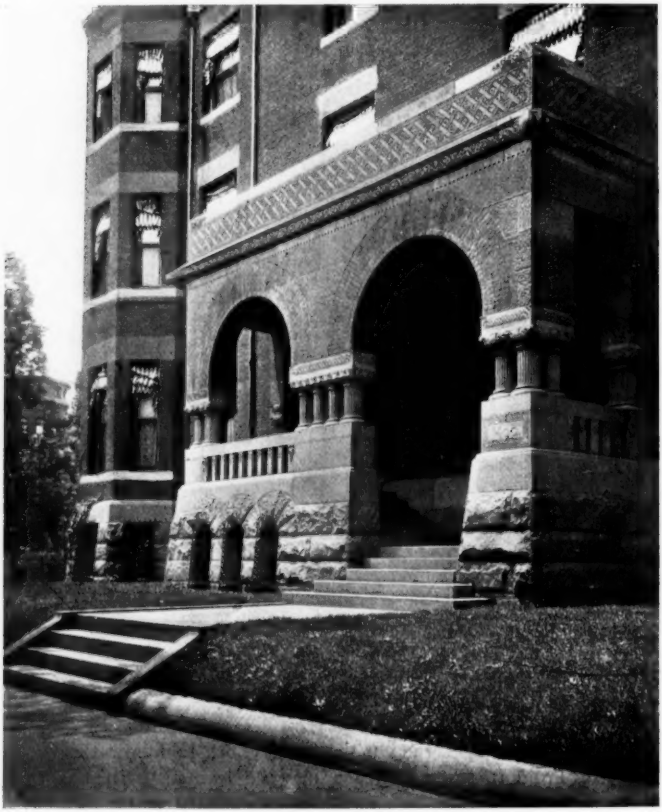
THE FRAZIER RESIDENCE.

THE LEITER RESIDENCE.

Colonial residence, designed without an effort to follow the style strictly. From it several lessons may be learned. In the first place, it appears to be too large for its site; the parking here is slight, and the grandiose appearance of the house seems to call

for grounds belonging to it. The building is not well proportioned in its masses, and the roof is deficient in repose. The color is not agreeable, the brick being very light, almost white, with white terra cotta details and red-tile roof.

Washington is, in truth, a beautiful city, charmingly laid out, admirably planned for convenience and effect, and adorned with many large public buildings, many of which have qualities of stateliness and repose, of dignity and of mass, which make them really admirable in their general effect and much superior to many recent buildings. Its



PORCH ; SENATOR HEARST'S HOUSE.

PARLOR ; RESIDENCE OF SENATOR HEARST.

HALL IN SENATOR HEARST'S HOUSE.

SENATOR HEARST'S RESIDENCE; THE MUSIC ROOM.

commercial buildings are not yet of first importance in size or in architecture, one or two hotels and office buildings alone disturbing the harmony of general spaciousness and uniformity of altitude. Its public buildings apart, the residences of Washington form the most considerable portion of its architecture. As in every city, these are of varying degrees of excellence; yet many are certainly entitled to rank with the best examples of American buildings in their class.

RECENT IMPROVEMENTS IN GOLD MILLING.

By H. M. Chance.

MANY persons well qualified to analyze existing conditions believe that the movement toward an enlarged output of gold is yet in an incipient stage. This belief is based upon the fact that, aside from those actually engaged in or interested in mining, there are few who as yet realize that the gold-mining industry is passing through revolutionary changes, that the cost of producing gold has been falling while its value has been rising, and that the so-called "boom" in mining has a sounder basis than the discovery of some new and rich gold-fields. Never before in the history of civilization have the environments of the industry been so favorable, never before has the prospect of profitable mining seemed so well assured, as at the present time, and never before have such facilities existed for quickly increasing the output. The facilities are at hand, the incentive is plainly in sight, the activity has already commenced, and the public will soon be forced to modify the old idea that gold mining is merely one form of gambling.

In the present article it is proposed to discuss some of those recent improvements in gold milling which have contributed to the present conditions by lowering the cost and increasing the efficiency of gold-milling processes.

The cyanid process was patented in 1889, and was first applied to practical work on a large scale in 1890. It is estimated that more than 750,000 oz. ($15,000,000) of gold was extracted from ores treated by this process last year. The results achieved by the extension of the chlorination process in the last few years are perhaps even more startling, and the increase in gold production traceable to reduced smelting cost may be estimated at a still larger quantity.

Prior to 1850 the art of mining and milling gold ores advanced sluggishly, development on modern lines being limited to those milling and metallurgical improvements effected in the Cornwall and Austro-German mining districts. The modern gold-mining era had its initial stage in the period of mining activity which followed the discovery of the Californian and Australian gold-fields. Mining in California quickly passed from the hand-work stage of washing stream and bar gravels, with the pan, rocker, long-tom, and sluice, to the hydraulic system, by which the alluvial deposits occupying ancient river beds were worked on an enormous scale and at almost incredibly low cost,—one noted operation showing a net profit from washing

material yielding less than three cents per cubic yard. This industry, however, was doomed from its very inception by the inevitable injury to agricultural bottom lands, and the damage to harbors caused by dumping millions of tons of *débris* into the rivers, and was soon crippled and finally killed by litigation.

The period marked by the development of hydraulic mining was one of activity in vein mining also, and many mills were built to treat the free-milling gold ores discovered in California, the American stamp-mill almost in its present form being evolved during this period, while the discovery of the Comstock bonanzas (1865) still further stimulated the development of stamping and milling processes. The second stage of development may be taken as covering the decade from 1865 to 1875.

Prior to 1875 gold mining was generally restricted to those veins of free-milling ore which contained not less than from ten to twenty dollars per ton,—no proposition showing less than fifteen or twenty dollars per ton being considered attractive,—and to veins of smelting or refractory ores showing assay values of not less than thirty-five or fifty dollars per ton. About this time the rush for the rich placer (gulch) discoveries of the Black Hills commenced, and the development of what is now known as the Homestake property quickly followed. It was soon shown that with cheap mining and good mill management ores yielding considerably less than ten dollars per ton could be worked with profit. This, it is true, had already been done in California, but the mining and milling costs at Deadwood, S. Dak., were soon reduced below those at any plant working under conditions fairly comparable to those present in the Black Hills; and, as the mills were increased in size and automatic feeders added, free-milling ore yielding less than five dollars per ton became the basis on which large dividends were earned. Simultaneously with this drop in mining and milling costs, the cost of milling in California was also reduced, and early in the eighties it was generally conceded that any large vein of five-dollar free-milling ore was a good proposition. As this opinion gained ground, it became the basis of a veritable boom in "low-grade propositions," this being the one class of gold properties sought after from 1882 up to about 1892. To it may be attributed the development of the great Treadwell mine in Alaska, profitably working a two-dollar ore, and a large number of mines in this and other countries working free-milling ore yielding less than four dollars per ton.

The possibility of profitably working ores so low in value is always predicated upon a deposit or vein large enough to insure cheap mining, and so located that supplies, fuel, and water can be obtained at moderate cost. It is further necessary that the gold should yield readily to

amalgamation (or yield cheaply to chlorination or cyanid treatment), and that it should not require fine crushing or grinding.

Looking backward almost thirty years to the stamp mill as built in 1868, and comparing it with the stamp-mill of the present time, the improvements are found to relate mainly to matters of detail in construction and design, in strengthening parts found to be weak, substituting materials better adapted to the strains and wear to which the various parts are subjected, and in altering their dimensions, the weight of the stamps, the size and style of cams, tappets, stems, and shafting, and the width, height, and depth of mortar, to suit varying conditions and to increase the capacity and efficiency of the whole. The practical effect of these improvements has been to double the capacity and efficiency, and to reduce the cost of maintenance more than fifty per cent. The addition of rock crushers, ample ore bins, and mechanical feeders has further increased the capacity and reduced the cost of stamping.

The successful working of all low-grade free-milling propositions depends mainly upon the ability of the mill to crush a certain quantity per stamp per day. On ore not requiring crushing finer than to a 30 mesh the output per stamp ranges from 2½ to 5 tons per day, the most successful mills passing from 3 to 4 tons per stamp every 24 hours.

Crushing to 30 or 40 mesh will rarely give as high a percentage of extraction (by simple amalgamation) as crushing to 50 or 60 mesh, and the size to which a free-milling ore should be crushed to yield the largest profit—not the largest gross returns—must be determined separately for each ore. As an example illustrating this problem, we may assume an ore which contains $4 per ton of gold yielding to plain amalgamation, of which 75, 85, 90, or 95 per cent. may be recovered by milling to 30, 40, 50, or 60 mesh respectively; a mill of 50 stamps putting through 4, 3, 2½, or 2 tons per day, according to the mesh used, at a cost of $120 per day total milling expenses; and a mining cost respectively of $1.50, $1.60, $1.70, and $1.75 per ton for 200, 150, 125, or 100 tons daily output,—the problem being to determine to what mesh the ore should be stamped.

Mesh	Tons per Day.	Min'g Cost pr ton.	Mining Total Cost.	Mill'g Total Cost.	Total Cost.	Cost per Ton.	Gold recover'd per cent.	Gold per Ton.	To'al Yie'd	Profit.	
										Per Day.	Per Ton.
30	200	$1.50	$300	$120	$420	$2.10	75	$3.00	$600	$180	$ .90
40	150	1.60	240	120	360	2.40	85	3.40	510	150	1.00
50	125	1.70	212.50	120	332.50	2.66	90	3.60	450	117.50	.94
60	100	1.75	175	120	295	2.95	95	3.80	380	85	.85

Reducing these assumed data to tabular form, it appears that, when crushing to 30 or 40 mesh with only 75 or 85 per cent. saved, the

profit per ton would be greater than when crushing to 60 mesh with a recovery of 95 per cent. of the free-milling gold. It might, possibly, be better policy to crush to 40 mesh with a daily profit of $150 (saving 50 tons of ore for future work) than to crush to 30 mesh and obtain a profit of $180 per day, the problem, under such conditions, being resolved into a question of whether the present value of fifty tons of ore left in the ground for future use is more or less than thirty dollars. The principle here illustrated has been the key-note to American free-milling practice, involving the pushing of mine, mill, and management to their greatest earning capacity, with large quantities handled at low cost, correspondingly large aggregate profits, and correspondingly large losses in the tailings. This practice has been carried to the limit, some mills running through a 20-30 mesh as much as 5 or 6 tons of ore per day. American milling practice is thus quite in harmony with modern management at large industrial works, where the "intensive" theory of production is applied by working every machine to its greatest capacity, regardless of ordinary wear and tear.

The excitement born of this species of mining development has subsided, leaving us, however, these well-defined principles, upon which the most profitable method of treating free-milling ores may be predicated, an established record of continuous dividends vindicating the wisdom of those to whose enterprise and ability we owe this knowledge.

Within the last few years the earth has been ransacked for large deposits or veins of ore carrying from three and a half to five dollars per ton free-milling value, and developments now progress slowly because such deposits are not plentiful, and also because veins showing this character at the surface commonly change into sulphid or refractory ores at comparatively shallow depth.

Precisely the same considerations, the same underlying principles, are the ruling factors of present practice in milling and treating refractory ores by the chlorination and cyanid processes. It is not a question of the highest percentage of extraction at the least cost, but of the greatest aggregate profit which a plant or mine can be made to yield; and the selection of the process, the appliances, and the method of construction and management of the plant to so treat the ore as to extract the greatest possible profit, involves considerations similar to those applicable to free-milling propositions, but requires also complete knowledge of the individual peculiarities of the ore, and of its behavior under the various conditions to which it may be subjected.

An important distinction may here be noted between the fields of labor occupied by the inventors of processes and appliances, and

manufacturers of apparatus and machinery for extracting gold from its ores, on the one hand, and by the mining engineers and mill-men on the other. The former class are always striving to devise methods and to manufacture appliances for extracting the *largest quantity of gold* from its ores at the least cost; the business of the latter class is to devise ways and means for so utilizing these methods and appliances as to extract the *largest profit* from a particular ore with the least expenditure of capital. One class has in mind the extraction of gold; the other, the extraction of profit. This distinction should not be overlooked; otherwise one may rely too much upon the inventors or manufacturers of milling appliances for advice upon questions which the mining engineer or mill-man is better qualified to consider.

The large capacity attained in present free-milling practice is due partly to the use of narrow mortars and a rapid short drop of the stamp, and partly to the relatively larger portion of the work now done by the rock crushers, and is finally made possible by the use of rather large mesh screens; successful amalgamation of the gold under such conditions can be traced to the narrow mortar, with moderately high discharge and the use of inside plates.

This construction and method of operation gives every particle of ore small enough to pass through the screens an opportunity of quickly escaping, while, with wide mortars and high discharge, such particles may remain in the mill until repeatedly caught below the stamps and reduced to powder. This construction is also well fitted for working certain special classes of ore, notably those requiring concentration, in which the subsequent treatment is made troublesome by excessive sliming, and to which it may readily be adapted by lowering the discharge and lessening the height of drop; even when very fine crushing is required, the narrow mortar, with moderately high discharge and short rapid drop of stamps, is capable of doing good work.

In addition to these changes in the proportions of the modern mortar, some minor improvements may be noted which increase its life by the addition of lining plates and increased weight; but these do not materially affect its efficiency.

The importance of maintaining a uniform height of discharge is generally appreciated, and several plans are in use by which this is more or less rudely approximated,—(1) by removable chuck blocks of different widths, (2) by inserting liners under the dies as they wear down, (3) by placing liners under the screen frame, (4) by making the top and bottom of the screen frames of different widths and reversing the screen, and (5) by placing a board, or two or more strips, against the outside of the screen, to be removed as the dies wear down.

Stamp-mills are better lighted than formerly, more window glass is

used, and electric lights have replaced the swinging oil lamps and reflecting lanterns, the tendency being to have all parts of the mill and machinery where they can be plainly seen and easily examined at all times.

Another improvement in mill design is a shifting of the main line of shafting back from the stamps, and in some cases raising it up so that the driving belts run nearly horizontally, thus prolonging the life of the belts, and placing the shaft, bearings, and pulleys where they are accessible and more readily examined.

Another important change is the rather general substitution of gyrating cone crushers for those of Blake style; this seems justified by the reduced cost and increased capacity. The advantages gained by the tendency to locate crushers at some point outside of the mill (often at the mine), the crushed ore being taken to the mill in dump cars or by conveyors, are: (1) the exclusion of the crusher dust from the mill, with correspondingly increased life of all the mill machinery; (2) the possible economy in feeding crushers by utilizing labor at the mine or shaft; (3) the gain of space in the mill, which may be used for enlarging the ore bins; (4) the elimination of the vibrations in mill frame and machinery caused by the crusher; (5) the relief from the irregular work and shocks thrown upon the mill engine by the crushers when these are run by belt from the mill shafting.

Another economy recently effected is that resulting from finer crushing of the ore before sending it to the stamp-mill, present practice favoring double crushing by passing the ore through one large and two small crushers.

The improvements recently made in the selection of material for shoes, dies, heads, cams, and tappets are merely such as may be expected from the use of such improved manufactures of iron and steel as may from time to time become available for these purposes.

Much has been done to better the design and arrangement of amalgamating appliances. As a rule, the management of amalgamation is turned over absolutely to the "amalgamator," and, as an incompetent man in this position may cause more trouble than a rebellious ore, a word here as to the professional amalgamator may not be out of place. The amalgamator is too often a tradesman, whose sole capital may be a few years' experience at one or two mills, fortified by the possession of a number of secret formulæ (handed down to him as trade secrets) which he has neither the knowledge or ability to use intelligently. A man of this character can generally be recognized by the air of mystery pervading his work, by his secretiveness regarding any chemicals he is using or the proportions of his mixtures, by his self-confidence (he always knows just how to amalgamate any ore that may be shown

him, but invariably declines or fails to say just how he would treat it), and by his ingenuity in blinding those around him to actual results, or in keeping the management on the *qui vive* anticipating the better results, which he is always just on the eve of accomplishing. An intelligent, sober, experienced, honest, and reliable amalgamator is not easily found, especially one with sufficiently varied experience to be of real assistance to the management. Perhaps our mill managers are themselves responsible for this state of affairs; for it often happens that, when such a man is obtained, his very honesty and candor in admitting his ignorance of some things bring about his discharge, and some more reticent, ignorant, and perhaps dishonest man takes his place.

There has been so much charlatanry pervading the whole subject of amalgamation that it is not surprising that managers with a reputation to sustain often prefer to leave the responsibility with their amalgamators rather than to assume it themselves by dictating methods or introducing innovations.

In keeping amalgamating appliances in condition to do the best work on any ore, there are many details which an experienced amalgamator will master better than anyone else, but there are some principles broadly covering this whole field of work which should be formulated and applied by the management.

Perhaps the most important factor in amalgamation is the extent or area of amalgamating surface. It does not seem possible to expose too much surface, and the greatest recent improvement is the tendency to increase both the length and width of the plates; so that from 4 or 5 feet the length of plates has grown to 8, 9, 10, or 12 feet with the full width of mortar from end to end. It is now well established that whatever amalgamation can be effected in the battery should be done there, and the inside plates are, therefore, made as large as possible. The value of the outside lip plate added by some mill-men can be measured by the amalgamated surface it presents. When the pulp, after passing over plates 10 or 12 feet long, carries more free gold or amalgam than good practice permits, it is sometimes passed over other plates (tailing plates), which may advantageously be arranged in steps, with a drop of from one to four inches from plate to plate. The impact of the pulp on the plate is supposed to force small particles of gold into more intimate contact with the plate than results from the undisturbed flow of the pulp, insuring the amalgamation of particles which otherwise might escape. Satisfactory results have also been obtained by making the tailing plates wider than the battery plates,—doubling the width,—by thinning the pulp, and by decreasing the pitch of the plates.

A pulp velocity or impact sufficient to cause a slight scouring of the amalgam, or a mere tendency to scour, when followed by decreased velocity with full surface for re-depositing any scoured material, has been found to increase the extraction. This may result from the scratched, file-like, and burnished condition of the plate at the point of scour, which is doubtless in prime order for a malgamation, and possibly may be caused in part by the mechanical force of impact, by which the film of water lying between the particles of gold and the plate is penetrated, and actual contact of the plate and gold assured. Whether this be the correct explanation of this phenomenon or not is, perhaps, immaterial, for the fact is well established that a portion of the free-milling gold may best be saved with a certain pulp thickness and velocity, while other portions may require different treatment; therefore the most rational and promising method of treating the tailings of such ores is by impact by falling on short plates, followed by wider plates and a thinner and slower flow of the pulp over them. Whatever benefits may be derived from these combined actions are realized, in part, at all mills using plates inside the battery and passing the pulp over outside plates of ample size, for the inside plates present a surface on which the effects of impact and tendency to scour are constantly operative, and the outside plates supply the remaining conditions.

While the possibilities of mercury and amalgam traps and of riffles, following plate amalgamation, in saving mercury, amalgam, and free gold, were worked out many years ago, the cheapening of smelting and extracting processes has recently re-developed and enlarged their field of usefulness, and they are now used at some mills to effect a cheap and crude concentration of the sulphids. In the absence of proper concentrating machinery, the saving of even a portion of the sulphids in this way is an advance on former practice, and in some cases is claimed to yield larger net profits than modern concentrators could earn.

Modern stamp-milling practice has been admirably described and discussed by Mr. T. A. Rickard* in a series of articles published in the *Engineering and Mining Journal* and in the *Trans Amer. Inst. of Min. Engrs.*, 1894-1896, to which the present writer desires to acknowledge his indebtedness for details not coming immediately under his own observation.

In the July issue of THE ENGINEERING MAGAZINE the subject will be resumed and concluded by a discussion of recent improvements and modernized practice in concentration, chlorination, and cyaniding.

* Other literature covering this subject will be found in the same publications by Prof. H. O. Hofman, Walter McDermott, P. W. Duffield, R. W. Raymond, E. E. Olcott, etc.

MODERN MACHINE-SHOP ECONOMICS.

By Horace L. Arnold.

III.—A MODERN PLAN FOR A MODERN SHOP.

THE ventilated gable roof is the form commonly adopted where the traveling crane is to be used, the ventilator walls rising just outside of the tracks for the crane-carrying wheels. This form of roof is common, also, in buildings not supplied with traveling cranes; the slope of the side roof surfaces naturally guides all currents of heated air to the ventilators, and the pivoted or hinged glazed sashes which form the ventilator sides very effectively aid the lighting, which is never all that is desirable on side-lighted shop-floors.

As the traveling crane must be at a very considerable height above the shop-floor, the side roofs and side walls are often carried so high as to give more than the needful head room over the side spaces not covered by the crane. This enclosed space is unused in the single-floored shop. If the side-wall windows are carried well up, this vacant overhead side space is well lighted, and also well warmed and well ventilated, and at first thought would seem to be an excellent place to fill with light tools and small vise work. Evidently all that is needed is to put in gallery floors reaching in nearly to the space covered by the traveling crane. So obvious are the advantages of this plan that most managers of ventilated gable-roof shops which are not supplied with gallery floors think well of it as a means of increasing floor-space, though but few superintendents who have had a thorough experience with galleried shops are hearty in their commendation. Even where there is a bridge in the middle of the galleries to mitigate in some degree the immensely long travel imposed on the foreman of the gallery floor, it is still a long distance round this part of the shops, and an observer on one of the side floors is too far away from the other side to see what is being done there.

While the gallery is not so bad as full multiflooring, it is, unquestionably far more difficult of access and observation than the single floor. It is a make-shift which imposes great labor on the superintendent who believes that the eye of the master can do more work than both his hands. It interferes with the lighting of portions of the main floor, and wastes a great amount of time and energy. It is a detached space, a foreign territory; and in some cases observed the gallery showed unmistakable signs of that neglect which is the inevitable fate of places reached with difficulty. In the case of single-floored shops having the crane space, side spaces, and the ventilated gable roof, the

environment is often such that the gallery is almost the only device available for furnishing needed additional floor-room. But no one who is once made familiar with the single-floored machine shop will ever willingly return to the multifloored or galleried type.

Economy in land cost is urged in favor of whole or partial shop multiflooring. Take a plot 100 feet square, at $200 per front foot; this costs $20,000, or $2 per square foot. Suppose 50,000 feet of shop-floor is demanded, and a five-floored structure is erected on the plot to meet the case; if built to cost less than $2 per square foot of floor, it is undoubtedly too cheap for economy. A space 20 feet wide next to the walls may be well lighted, if the building is isolated; this leaves a badly-lighted space 60 × 60 in the middle of each floor, which must be artificially lighted a great part of the time. One of the largest cycle factories has floors nearly as specified, all of which have practically waste places in the middle, the foremen and workmen arranging matters so as to make the most use of the light at the sides. In addition to this obvious disadvantage of comparatively unproductive territory, men must walk through or around this unremunerative space; and materials, and work in progress, must increase the length of their journey. Elevators and stairways very greatly reduce the usable floor area, and the most valuable time of men in responsible positions is wasted in the laborious effort to obtain information by personal observation. Indeed, in the multifloored shop the manager generally finds it absolutely impossible to exercise personal oversight; he adopts a policy of dependence on the reports of others; he cannot go to see his foremen or their departments, and hence has his subordinates come to him, and is at their mercy. A foreman must be a man of rare honesty, intelligence, and powers of imparting information, to give his superior an absolutely correct and full idea of affairs in his department. The manager becomes suddenly and unpleasantly aware that he does not know the real state of things in his establishment, and he has either to fight enemies in the dark, or leave his own duties unperformed while he sees things outside of his office with his own eyes. The greatest possible lack in shop management is a lack of knowledge of the real condition of things in the shop departments; and it is safe to say that there is not at this moment a manager of a multifloored machine shop living who has not, back of all his other thoughts, an uneasy sense of this deficiency. This is a condition inseparable from the multifloored shop. All bodies move in the direction of least resistance. The manager, no less than the workman, will try to do his work in the easiest manner; if he has to choose between being on his feet all day outside of his office, thus of necessity neglecting his own especial duties, or sitting in his office and accepting the reports of others, he will infalli-

bly elect to do his own work himself, and obtain his knowledge of shop affairs at second-hand. Of the two evils he accepts the one least distasteful to himself, and falls back on the resolve to have subordinates on whom he can depend.

Returning to the ground cost of $2 per square foot; if the shop had been made single-floored to cover an area of 50,000 square feet, the first cost would have been very little more than that of the five-story shop on the plot 100 feet square. The necessity for expensive foundation and the need of costly fire-proofing disappear together, when the single floor is adopted. Almost any soil will support single-floor loads without special foundation work. Supposing even 100-ton cranes to be installed on ground requiring piling; at a load of 12 tons per pile, only four or five piles need be driven under each supporting column of the crane ways; for cranes up to 50 tons the crane ways are an easy engineering problem. Without cranes, or with such cranes as are used in the Straight Line Engine Shops, where the total weight of the hand traveling crane having a five-ton lift is only two tons, the cost might easily fall below that of the same multifloored area on less land. In this case the fixed charge of realty interest would be the same for both structures. But the first cost of land and buildings is not the most important item, and in any case the buildings inevitably decay and constantly lose in value, while land may, and commonly does, constantly increase in value in manufacturing localities in compound interest ratio, by that very lapse of time which extinguishes building values. Hence, on the face of things, it is economical to put a single-floored shop on a large piece of ground rather than to put a multifloored shop on a small piece of ground.

But it is the cost of labor, not buildings, that chiefly concerns the manager who seeks economical machine construction.

Suppose 50,000 feet of floor surface to work 500 hands at an average of, say, $10 weekly, or $250,000 total yearly wages in a shop costing, say, $2.50 per square foot of floor=$125,000, which, at 5 per cent., gives a fixed interest charge of $6,250 yearly. If the single-floored shop can save 2½ per cent. of this pay roll, it will gain $6,250=the total 5 per cent. interest charge.

The former shops of Sterling Cycle Works, Kenosha, were in a multifloored building in Chicago, with stairways and elevator. The elevator man was paid $1.25 per day; the general manager therefore placed the cost of running the elevator at $7.50 per week. I believed it was at least $15 per day, from what I had observed in the shop, and Mr. Timm, superintendent, and also designer of the present shop, gave $25 per day as the very lowest extra expense due to the elevator. The general manager had never viewed the elevator question from the standpoint

of all costs included, and demurred very strongly. Mr. Timm proceeded to fortify his statement with such details of the work of the current day as made it clear to the manager that $150 per week was a really low estimate. If any manager will make a mental picture of the scene at the elevator shaft on each of the six floors of a busy factory, and trace the course of each truck-load of stuff which comes to the elevator for raising or lowering, he will conclude that the pay of the elevator man is only a very small part of the total labor cost of elevator service. In very recent conversation the Sterling manager asserted that the new single-floored shop made a saving of over ten per cent. in labor cost of production ; he said, also, that the good light and ventilation, absence of stairways, and general convenience of the shop gave them the pick of the workmen, simply because it is easier to work in an agreeable shop than in badly-lighted and inconvenient quarters. Going back once more to the supposititious shop structure, 10 per cent. of $250,000=$25,000 possible yearly saving due to the shape of the work-floor of the shop, if the Sterling manager was correct in his statements.

Undoubtedly such a conclusion as this is likely to be pronounced an absurdity by many excellent and experienced managers, the first point made being that the management of the Sterling must have been very poor in the old shop and very good in the new. Fortunately the management and the superintendence are the same in the new shop as in the old, throughout. Let any manager take notice of the cost of handling work in his establishment ; let him also take notice of the unproductive labor of the workmen in going up and down stairs, and in walking from one place to another ; let him also estimate at its true detrimental effect the needless labor put on foremen by elevators, stairways, and waste places in multifloored shops ; let him become fully aware of the needed things not done because of the needless doings entailed by faulty and avoidable shop structures, causing faulty lines of shop travel and sequence ; and he will then begin to understand the far-reaching influence of the shape of the shop on the cost of the finished product.

The De La Val shops, designed by Mr. Frederick Hart of Poughkeepsie, N. Y., not only offer all possible advantages in the way of form and light and reduction of superintendent's work, but have the singular feature of extensibility in these directions without tearing down and throwing away any material whatever. As the De La Val shop manufactures only a single machine in different styles and sizes, and is a manufactory pure and simple, having no commercial relations save with the New York headquarters, the shops require only small offices, which are located over very low rough-stock store rooms in a two-

floored building totally different in construction from the workshops. This stores-and-offices-building is extensible from either end. The superintendent's office commands a view of the entire machine floor, as that officer sits in his chair at his desk, and a very easy short stairway puts him on the shop floor. The drawing-room is on one side of the superintendent's office, and the book-keeping department is in front of it; for a medium-sized shop, requiring a small office force only, the arrangement is admirable, but the offices are not sufficiently extensive for a machine shop doing a general business.

Supposing a machine shop is to be built in a thickly-populated district on a plot accessible from one side only, can a good arrangement of departments be made, and, if so, can a homogeneous structure be devised which will suitably house both shops and offices? This is a question often asked, and commonly answered in the negative. The accepted alternative is to abandon the town idea altogether, and seek a suburban location, where air and light can be had on the four sides of the buildings. Nevertheless, the problem is not impossible, but, on the contrary, has a rational solution at a very low cost, which perfectly answers all needful conditions, and, excepting in the one particular of approach through squalid and unprepossessing surroundings, can give both workshops and offices of the most desirable character.

Air is the first necessity. There is some place in any reasonably large plot of ground, no matter what its surroundings, where a moderately high air stack will open up into a tolerable atmosphere; at no very great expense the air drawn into the proposed shops through this stack can be washed, dried, and either heated or cooled, as may be needed, before it is distributed through the establishment by blowers. Some rooms in Chicago, where a great number of workers are closely placed and the atmosphere is so vile a compound of dust and smoke as to render satisfactory operation of delicate mechanism impossible, and where nausea, head-ache, and impossibility of concentrated attention were common happenings among the toilers, are now entirely shut up, and supplied solely with washed and dried air, with the most agreeable and economical results. But in most cases it will be enough to take the air in at the top of a shaft of no excessive height. This disposes of ventilation.

No building of any considerable width can be evenly lighted from the sides in a suitable manner for the machine shop. The top is the only surface of a building which cannot be darkened by the erection of contiguous structures. No one who has never seen a machine-shop interior lighted by the saw-tooth roof can have any adequate idea of the effect of the abundant overhead illumination which it

secures. The arrangement of glazed slopes facing the north, and solid roofing toward the south, secures a strong, but agreeable, diffused light, never needing to be curtained, because it is never directly from the sun, and never affecting the eye of the workman unpleasantly, because it falls from above and makes the natural shade of the forehead always effective.

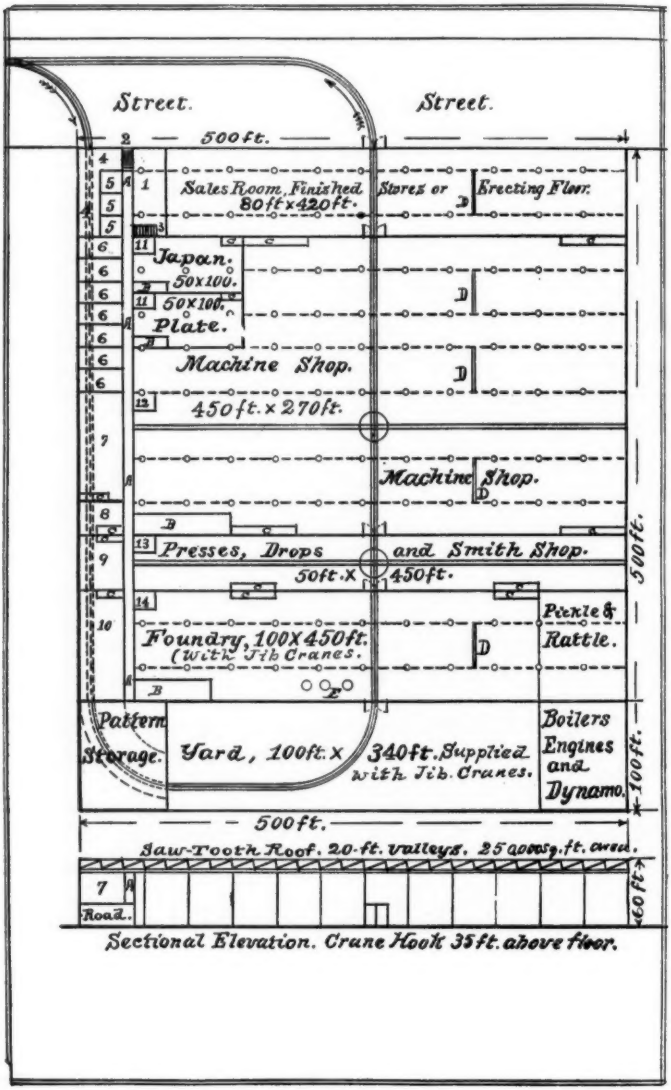
The only real problem connected with the saw-tooth roof is the valley gutter, and this detail has been so fully and simply and cheaply worked out by Mr. Hart in the De La Val building as to make the heaviest snowfall a matter of no inconvenience whatever. The expansion-mounted metal gutter is semicircular in section, and slopes one inch in ten feet, each way from the mid-line, and a steam-pipe running under the whole length of each gutter close to its lowest point assures a clear water-way in the gutter bottom under any possible conditions of snow-load and outside temperature, and also avoids any possibility of drip from condensed moisture on the under surface of the gutters. Such dripping falls upon the steam pipe underneath, and is at once vaporized and absorbed by the air. The valleys of this roof should run east and west, but this makes little difference, as the valleys can run either way of the shop here proposed without inconvenience. With a drainage inclination of 1 in 120 a 500-ft. roof would have a gutter elevation difference of 25 inches; but the gutter system can be divided into any length of individual drainage areas, leaders from the lowest point of each being carried down the crane-way supporting pillars to the subterraneous sewer system.

Since the supposed shop site is accessible from one side only, and since every work-shop should have two clear roads, one for entrance and one for exit, the width of one roadway is taken from one side of the plot, covered by the offices-gallery, and connected by curves or turn-tables, as the case may require, with a half-length branch in the yard at the end farthest from the one street, to the second roadway, which leads from the yard in the rear through the middle of the shops back to the street again. The margin road is for incoming material, and the middle road for advancing parts of work in progress and shipping finished work: in case, however, of incoming material in the form of heavy casting or forgings, the middle road, which is served by cranes in each division of the shops, can be used for reception. The plot is supposed to be nearly square; if it is very much greater in one dimension, so as to make a long narrow building a necessity, the number of cranes required would be considerably increased, because the proposed design contemplates cranes in all cases traveling at right angles to the middle roadway, so that any piece in crane-served space may be picked up and carried to the roadway; and delivered to the road to

be carried to another department or shipped outside. Generally, the space of shop-floor served by cranes need not be, I think, over one-third or one-half of the entire area; but this is a matter of discretion and choice, as the design here suggested permits serving the entire floor, or any desired part of it, with cranes, while the middle road opens heavy transportation between all the crane-served areas with one slinging only. The margin-roadway is wholly enclosed for the length of the building as it runs beneath the offices, drawing and experimental rooms, and pattern shop. The pattern storage-room should in all cases be a detached fire-proof structure, in the yard, adjacent to the foundry, and connected therewith by a covered way having two floors, one leading from the pattern room and one from the foundry.

These conditions immediately determine the arrangement of the gallery departments over the marginal roadway. The pattern shop is in the extreme rear, next to the yard and pattern store-house, and next to the foundry; next to the pattern shop comes the model and experimental room, in case this department is put on the gallery floor; next the drawing-room, and then the office of the mechanical engineer, that of the general superintendent, and still outward toward the street the book-keeping, with the weighmaster over the roadway in front, and the business manager's departments also in front. The department foremen have their offices at the department entrances, which are from the margin road, with wash and locker rooms for their own men opposite, and elevators and speaking-tubes from each foreman's room to the gallery floor. This brings the superintendent within a few minutes of every official in the entire establishment, and affords any official facilities for visual observation of everything under his charge which are not present in any previous workshop design within the knowledge of the writer. As shown, one-third of the floor is covered by cranes, the spaces between the rows of crane-supporting pillars being twice as wide as the crane length. The heavy hammers are farthest away from the gallery, so as to interfere as little as possible with the drawing-room and the pattern room. Work in progress travels from the yard, the foundry, and the smithy toward the street, and the show-room for finished work and customer's reception-room and business offices are on the street.

The writer has not the vanity to claim perfection for this shop design; it is put forward, as was stated at the outset, as a composite design wholly made up of features from actual practice, grouped in a manner to meet the obvious needs of an industrial structure of considerable extent. In case of only partial construction at first, the building would begin at the line of the yard, perhaps with the foundry and smithy in one division, and the machine shop in the next, with only



PLAN OF THE PROPOSED SHOPS.

For explanation of figures, see next page.

part of the pattern storage-house; and the buildings could be extended, as desired, toward the street, up to the full size of the plot. The unused space in front of the partial shops could be kept up, as at the Link Belt Engineering Shops, Chicago, in ornamental form with lawn and flower-beds, at small expense, amply repaid by favorable effect upon the first impressions of visitors, and upon the spirit and personal conduct of the workmen. Nothing is more conducive to the elevation of the mental standards of employees than an object-lesson of this kind in their immediate environment. Until our advancing civilization brings an increased appreciation of the intrinsic value of beauty, it is sufficient to suggest that, within reasonable limits, it is a factor of sound practical business policy.

A better external architectural effect is secured, if the side walls are carried up to conceal the unpleasant exterior effect of the saw-tooth roof. The engine-room may be placed in the yard, to balance the pattern storage-building. The power transmission may be by wire to motors driving short or long lines of shafting carried by the crane-supporting pillars, or by separate shaft supporting structures, as in the Gates Iron Works, or by individual tool motors, as in the Baldwin wheel-room.

While disclaiming all assumption of originality, the writer ventures to hope that this proposed form of industrial structure will be received as an assemblage of good features of late practice worthy of consideration by intending builders.

REFERENCES TO SHOP PLAN ON PAGE 476.

1. Sales and shipping offices; 30×80 ft.
2. Stairway from street to office gallery; 20 feet rise.
3. Stairway, office gallery to sales and shipping; 20 feet rise.
4. Weighmaster and bookkeeping; 80×20, with "L" 20×20 ft.
5. President's offices, 3 rooms, each 20×20 ft; communicate with each other and gallery "A."
6. Separate offices, 20×40; open on gallery "A."
7. Drawing room, 40×100; open on gallery.
8. Test and analysis, 30×40; open on gallery.
9. Model and experimental room, 40×50; open on gallery.
10. Pattern shop, 40×100 ft.; open on gallery and to pattern storage house, 80×100 ft., 3 floors, fireproof.
11. Japan and plate foremen's offices, 15×20; elevator to gallery A; lift 20 ft.
12. Machine floor foreman's office, 15×20, elevator to gallery A; lift 20 ft.
13. Press and hammer room foreman's office, 15×20, elevator to gallery "A"; lift 20 ft.
14. Foundry office, 15×20; elevator to gallery.

A. Office floor or gallery corridor 10 ft.×500 ft. Glass partition overlooking shops on right hand (north) side; communicates with all offices and gallery rooms, and runs from the street to the pattern storage house. The gallery floor forms the roof of the in-road; 20 ft. clear above road way.

B. Wash room and lockers.

C. Closets.

D. 40 ft. span traveling cranes, high-hook 35 ft. above main floor.

E. Cupolas.

THE ELECTRIC VERSUS THE HYDRAULIC ELEVATOR.

By Wm. Baxter, Jr.

THE electric elevator proper—that is, the self-contained elevator machine—came into use about seven or eight years ago. For three or four years previous to that time ordinary stationary electric motors had been installed in factories and warehouses to furnish power for operating freight-elevators; but in all such cases the common type of power elevator machine driven by belts was used.

The real cause which led to the development of the electric elevator motor is perhaps not generally known. The general impression is, no doubt, that inventors saw a demand in that direction which, if satisfied successfully, would yield a large reward; and that they, therefore, set themselves the task of solving the problem, and persuading elevator builders to manufacture their machines. This conclusion, however, would be just the reverse of the facts; it was through the efforts of elevator builders that inventors took up the subject.

How this came about can be briefly explained.

Twenty-five or thirty years ago few buildings of more than five stories were erected, and elevators were looked upon as a luxury, not as a necessity. With the advent of high buildings with fast-running elevators, conditions were changed. Men who a few years previous thought it no hardship to climb up four flights of stairs moved into the new structures where stair-climbing was unnecessary. As a result, the owners of the older structures found that they would have to reduce their rents, or introduce an elevator. The latter expedient was adopted in many cases, but there were many others where it could not be, either on account of lack of room for the installation of a hydraulic-elevator plant, or because the cost of operation thereafter would be more than the revenues of the building would warrant.

This was the situation about twelve years ago, and the elevator builders were compelled to contemplate the fact that there were hundreds, if not thousands, of buildings in most of the large cities that would install an elevator at once, if they could only get something that would not cost more to introduce and operate than the rentals would permit. The fact that they were unable to meet the requirements in these cases with their hydraulic apparatus led them to consider the possibility of finding a solution of the problem in some other direction; and, as the practicability of the electric motor had then been dem-

onstrated, it was natural for them to suppose that it could be adapted to elevator purposes in a compact, efficient, and durable form.

At the request of several of the officials of one of the large corporations in the elevator field, the writer took up the subject in the summer of 1884, and designed an electric elevator, as well as several arrangements for electrical control of the motion of the car. These officials were very enthusiastic upon the subject, and anxious to start the manufacture of electric apparatus at once; but the president did not believe that the time had come for such an innovation. A few months later, the writer embarked in another branch of the electrical field; but the officials of the elevator company, who believed in electricity, continued to advocate it, and with such success that they soon began to experiment in that line, and in 1888 brought out an electric elevator, which was, perhaps, the first practical self-contained machine placed upon the market.

From the foregoing it will be seen that the electric elevator came into use through the efforts of hydraulic elevator builders, whose object was to develop an apparatus that could supply a demand for which the hydraulic was not adaptable. Soon after this the various manufacturers of hydraulic elevators entered the electric field, not so much because they believed in it as to keep abreast of the times.

About five years ago new corporations, organized for the purpose of building electric elevators, began to come to the front, and to-day there are a number of such concerns, of which two at least are doing a very large business.

The manufacturers of hydraulic elevators have never looked upon the electric as a real competitor, but have considered it as a valuable adjunct adapted to small buildings, where space is limited, and where the cost of operation of a hydraulic plant would be abnormally high; they insist that for large buildings, where a complete power plant must be installed, and where the very best results are required, not only in economy of operation, but in perfection of control, smoothness of motion, etc., the hydraulic is the best, and is in no danger of losing its supremacy. Those who are engaged in the manufacture of electric elevators exclusively maintain of course that their system is the best under all conditions and for all purposes; that it is not an adjunct to the hydraulic, but a direct competitor of the most formidable kind. Judging from the results achieved within the last few years, the latter claims are not without foundation, and theoretically they appear to be unassailable. It would be contrary to the facts, perhaps, to say that at the present time the electric elevator is equal in every respect to the hydraulic, for, in the matter of certainty of control, the latter is undoubtedly superior. But it is possible for the former to be made equal

to it in this respect, inasmuch as the difference is so small that it can be noticed only by an expert. In other directions the electric is superior even to-day. Therefore, if we compare the advantages and disadvantages on both sides, the probabilities are that the scales would be turned in favor of the electric elevator.

An investigation of the main features of both systems will serve to show their relative merits more clearly.

In the hydraulic system steam pumps are used to force water into a pressure tank, from which the hydraulic cylinder that actuates the elevator is supplied. In a complete electric system a steam engine is used to drive an electric generator that supplies the electric energy for operating the elevator motors. We have the efficiency of the steam pumps and the hydraulic transmission and transforming apparatus in the former case, to compare with the efficiency of the steam engine and electric generator, and that of the electric transmission and transforming apparatus, in the latter. As is well known, the efficiency of steam pumps of the size and kind used for elevator work is much lower than that of steam engines of the same size; therefore, the unit of energy delivered to the water pipe by the steam pump will cost more than that delivered by the electric generator to the line conductors.

The loss in the transmission and conversion of energy, in the hydraulic system, between the pump and elevator car cannot, without the use of very expensive piping, be made as low as the loss between the generator and elevator car in the electric system. From this it follows that the cost of energy delivered to the moving car will be lower with the electric system. As an offset to the evident advantage of the electric system, as shown in the foregoing, it is pointed out that, in the hydraulic system, the pressure tank acts as a storage reservoir of energy, and that, owing to this fact, the pumps can be made to work at a more uniform rate, and at an output that more nearly approximates the point of highest efficiency. This claim is based upon the fact that the energy required to operate an elevator car is variable within wide limits; the greatest demand is made at the instant of starting with the maximum load, and from this maximum the demand reduces to zero when the car is not in motion. As the capacity of the pressure tank is several times that of the hydraulic cylinder, it is not necessary for the pump to be of sufficient capacity to equal the maximum demand, as any excess of energy drawn at such times can be compensated when the demand falls below the pump capacity. It is evident that, if the pressure tank is large enough, the pump can be made of a size equal to the average amount of energy required to operate the elevator, and that it can work uniformly at this rate. The tanks are never made so large as to fully realize this condition, but they approximate it closely; therefore

the pumps can be operated at a point very near to that of the highest efficiency.

As the electric elevator has no storage device, the engine must be of such capacity as may be necessary to meet the maximum demand, and, as this is far above the average, the defenders of the hydraulic system claim that it reduces the actual efficiency of the steam engine to about the same level as that of the pump, owing to the fact that the average output of the former is far below the rate of highest efficiency.

This assumption would hold good, if only one elevator car were used; with two cars, the difference between the average and the maximum demand would not be so great, as both cars would not require the maximum supply at the same time. As the number of cars is increased, the difference is reduced, and, with a plant of, say, six or more, the difference between the greatest and the least demand for energy would not be great; so that an engine capacity slightly in excess of the average would meet the requirements perfectly. It is, therefore, evident that, in large installations, the hydraulic system cannot offset the higher efficiency of the electric by reason of the storage capacity of the pressure tank, because in such cases the average and maximum demands for energy are so nearly equal as to eliminate the advantage of a storage capacity.

With an elevator plant of five or six cars, or more, there can be but little doubt that the cost per unit of energy delivered at the car will be lower with the electric system; therefore, the total cost of energy will be less, even if the same amount is used in both cases. But, with an electric elevator of the drum type, the energy required to perform the same service can be made much less than would be required with a hydraulic elevator. This is due to the fact that, with the former, the weight of the car can be overbalanced, and, if the excess of weight in the counterbalance is made equal to the average load, the energy required will be equal to the frictional resistance plus the amount absorbed in accelerating the unbalanced weight. When the car is overbalanced, the actual weight that has to be lifted can be made much less than when the load is underbalanced. For example, suppose the car weighs 2,500 pounds and the balance-weight 1,800 pounds; we then have 700 pounds of unbalanced weight. Suppose the average weight of passengers to be 1,000 pounds; then the total load would be 1,700 pounds. Now, if we increase the balance-weight to 3,500 pounds, it will overbalance the car 1,000 pounds, and thus just balance the weight of passengers, making the actual load zero. In the case of the underbalanced car, the energy required to move the load would exceed that required with the overbalanced car by the amount necessary to raise 1,700 pounds at the velocity with which the car travels.

The energy absorbed at the instant of starting an electric elevator is very much greater than that used when the normal velocity is attained, and this fact has led many to believe that, as stops have to be made at most of the landings, the average efficiency would be considerably cut down. But this is not necessarily so. Part of this excess is lost in the resistance introduced into the electric circuit to keep the car from starting off with a jump, and part through the inefficient action of the motor when the velocity is so near zero; but another portion is absorbed in producing a high rate of acceleration. The first two losses are absolute, but they are of very short duration; the last loss is only partial, because, if the rate of acceleration is greater, the maximum velocity will be attained sooner, and, therefore, a lower maximum is compatible with the same average velocity. From this it follows that a trip from the ground-floor to the top of a building can be made in the same length of time with a lower maximum velocity, and therefore lower maximum expenditure of energy. Hence the gain in this direction will go far toward offsetting the loss in starting.

There is another fact that contributes to the higher efficiency of the electric elevator which is very generally overlooked,—namely, that the hydraulic cylinder must be of sufficient capacity to start the car with the maximum load at a fair rate of acceleration; therefore the energy used at all times per unit of distance traveled by the car is equal to that absorbed at the time of starting.

At the present time the tendency is to increase the speed of elevators, owing to the fact that the height of buildings is constantly increasing. With higher velocities the weight of counterbalance in hydraulic elevators must be reduced,—that is, if an independent counterbalance-weight is used. If the hydraulic cylinder is vertical, the counterbalance may be placed on top of the piston, or on the crosshead; but this is objectionable, on account of the enormous weight, required by the fact that the velocity of the car is at least ten times as great as that of the piston. In the majority of cases the cylinder is horizontal, and an independent counterbalance is used. If the velocity of the car is low, the counterbalance may be equal to seventy-five or eighty per cent. of the weight of the car; but, with high velocities, it will have to be considerably reduced, in order to avoid accidents by sudden stops on the up-trip. To illustrate this point, suppose we take the case of a car ascending at a velocity of seven feet per second. If the motion of the lifting ropes were arrested instantly, the distance through which the car would rise before coming to a state of rest would be equal to the momentum divided by the retarding force. If the car were unbalanced, the distance would be equal to the space through which it would have to fall to attain a velocity of seven feet per second

under the acceleration of gravity, and this would be about nine inches. If the car weighs 2,500 pounds, the counterbalance 1,800 pounds, and the ropes 400 pounds, the distance through which it would rise, when half-way up the building, would be about 4.8 feet, and, when near the upper landing, about 7.5 feet. Now, an electric elevator, balanced from the drum, will act as if not balanced at all, because the counterbalance-weight does not act directly upon the car. Therefore, if the motion of the ropes were instantly arrested, the car would continue in its upward course nine inches further, and slack up the ropes to that extent. This would do no serious damage, if suitable guards were provided to keep the ropes from jumping off the upper sheaves. If the counterbalance ropes run directly to the car, the distance traveled at the top of the building would be as great as 7.5 feet, and, as the car would drop back this distance, unless caught by the safety catches, the results might be very serious.

From the foregoing it follows that, if very high velocity is attempted with cars counterbalanced directly, the weight of the latter must be very much reduced to insure safety; and this means that the efficiency, as compared with machines of the drum type, will be reduced with an increase in velocity. It may be said that, as the elevator generally carries a load, the distance through which it would rise by the force of its acquired momentum would be less than stated above; but it very often happens that only one passenger goes to the top landing, and in such cases the movement would be about as above stated.

I have said that in certainty of control the electric elevator is not equal to the hydraulic. This fact can be easily seen from the following. The motion of a hydraulic elevator is controlled by the movement of the valve through which the water enters the cylinder. As water is practically incompressible, it follows that the car will stop the instant the valve is closed. If the elevator-operator moves the valve at a rate that will close it while the car is traveling, say, three feet, a stop will be effected in this distance, whether the car is running fast or slow. In order to avoid too violent a stop, the hydraulic cylinder is provided with a release valve, through which the water may escape, should the main valve be closed too quickly. But this valve seldom comes into use, as a very little experience enables the operator to tell how fast to close the main valve. As the speed begins to reduce from the moment the valve is moved, it drops to an almost imperceptible motion when the landing is reached; then a final movement closes the valve entirely, and the car stops just at the desired point.

With an electric elevator the conditions are very different; the car is stopped either by the resistance of a friction brake, or by converting the motor into a dynamo, for the time being, or by a combination

of both these means of retardation. If these resistances were constant under all conditions, the distance in which the car could be stopped would increase with the velocity and the load; but, as it is often necessary to make a quick stop when the car is running at a high velocity, these resistances must be variable. The various manufacturers resort to different means for accomplishing these results, but, from the very fact that the friction of a brake is variable even under practically the same conditions, its retarding action cannot be depended upon to be always equal to the requirements. The dynamic action of the motor is more reliable, but there is, nevertheless, a lack of absolute certainty of action. For these reasons, the control of electric elevators, as now made, is not so positive as that of the hydraulic, but further improvements will no doubt make them equally so. The difference in this respect, as already stated, is so slight that only an elevator expert can detect it, and, if the operator has had sufficient practice with the car, he can control its motion in a manner that is highly satisfactory.

While the controlling devices of an electric elevator are not so positive in their action as those of the hydraulic, they render possible the elimination of the objectionable hand-rope. In nearly all the hydraulic elevators now installed, the hand-rope is moved by a wheel or lever of some kind. This is an improvement on the old process of pulling directly upon the rope, and enables the operator to control the car with greater certainty; but it is crude when compared with an electric controlling system, in which nothing is visible in the car but a diminutive switch-box.

As the movements of the elevator car in an electric system are effected by variations in the direction or strength of current, the cumbersome hand-rope can easily be dispensed with; but up to the present time only one company appears to have adopted an electrical controlling system exclusively. At first sight this problem would appear to be very simple, but close investigation will show that it presents many difficulties. Competition, however, will no doubt compel all to abandon the hand-rope in the course of time.

As to the prospects of the two systems, there can be but little doubt that those of the electric are the brighter. While the advocates of each may continue to struggle for supremacy, certain causes beyond the control of either may finally turn the scales in favor of electricity, and leave it in undisputed possession of the field. In large buildings, heretofore erected, it has been customary to install an electric-lighting system, the reason being that, as the hydraulic-elevator plant required a battery of boilers, it was a simple matter to enlarge this somewhat, and add a steam engine and electric generator to the already extensive installation; in this way the lighting is obtained at a

cost only a trifle greater than that of the extra coal consumption. This is true where a hydraulic elevator plant is installed; the running expenses, as well as the amount of machinery with which the building is encumbered, are not increased very much by the addition of the lighting plant. But the advent of the electric elevator has rendered it possible to view the subject from a different standpoint. The electric-elevator advocates say that an electric power plant to operate elevators as well as lights would be more economical and simple than two distinct plants, one hydraulic for the elevators, and one electric for the lights. But would it not be still more simple to discard the power plant entirely, and obtain current from the street-mains for elevators and lights as well? It may be said that the charges made by the lighting company for current would be much greater than the cost of generating it on the spot. This would be true with a very large plant, but would not be true with a small one. Just where the dividing line would come, where the two methods would be of equal cost, it is difficult to say, as it would depend upon conditions peculiar to each case. But, even if the current from the street mains should cost more, it would in many cases be preferred, on account of its doing away with all the machinery with which the lower part of the building would otherwise be encumbered. That this view of the subject has been taken in many cases is demonstrated by the fact that a number of large buildings have been erected within the last year or two, in which this course has been followed. Thus it may be that for this reason alone the electric elevator may eventually drive the hydraulic out of the field, regardless of whether it is more economical, when a power plant is installed, or not.

In conclusion it may be said that a full consideration of the various designs of electric elevators that have been proposed, or even of those that have actually been made, is not practicable in a short article; the discussion, therefore, has been confined to the drum machine as it is the kind made by prominent builders with but a single exception. Several other types have been tried, and one of these, the horizontal screw machine, has obtained considerable prominence, owing to the fact that it has been used in nearly all the most important installations with highly satisfactory results. The manufacturers of this machine, although makers of drum machines as well, regard the screw type as the best. If their belief is well founded, it will become the standard machine of the future, but at the present time the drum type is used not only by all the prominent builders, but also by the numerous smaller concerns; therefore it must be considered the typical electric elevator of to-day, and the proper one to use as a basis for comparison.

BANK REVETMENT ON THE MISSISSIPPI RIVER.

By H. St. L. Coppée.

IF, upon a sunny day, one could occupy an observation station well above the surface of the earth, over the center of the Mississippi valley, and could look with magnifying eyes on the objects beneath, far to the north he would discern a small bright spot of water, from which emerges a winding crystal stream, tracing its course by plain and forest, over shoal and rapid, ever increasing in strength and volume till it reaches the prairie's level. Through the heart of the continent he would trace this river, flowing on until, with the mingled waters of the Missouri and Ohio, draining nearly a million square miles of territory, it emerges from its limestone bed to creep like a great yellow snake through the broad alluvial plain which, since prehistoric times, has been built up from the paving of cenozoic shells once underlying the ocean. In its lower reaches he would see it ever winding through seemingly endless chains of curves, taking from the crumbling bank its load of earth and vegetation, destroying plantation and village, until with its work completed it passes the narrow portals of the gulf, and deposits its burden in the depths of the sea.

At the present time the Mississippi river in many places presents much the same appearance that it did over three hundred years ago. As DeSoto saw it, we see it in some of its reaches to-day, but a civilized nation has replaced the naked nomads of the discoverer's time; prosperous cities occupy the sites of primitive forts, and powerful steamers navigate the ever-changing channels, carrying the rich products of field and mine to be distributed in the markets of the world.

With the change from savagery to civilization came the necessity of controlling this mighty river that poured over field and forest during the spring and summer flood, and in the fall and early winter crept between sandy bars with insufficient depth for navigation, at all stages destroying and building, constantly expending its force to the detriment of riparian owner and navigator.

The Mississippi, in its lower reaches, from Cairo to the gulf, is purely an alluvial stream, flowing through a low-lying land subject to overflow. Its high-water season may be approximately stated as continuing from February to May inclusive, and the low-water season from September to December, the other months of the year marking the transition periods. Its numerous bends have no uniformity of radius or depth, each, with its accompanying bar on the convex shore, ter-

minating in a shoal or crossing where the curve is reversed and the water cuts through the continuous chain of sand.

The banks are formed of strata of sand, buckshot,* and clay, of varying thickness. During the high stages the water scours the bank on the concave side in the bends, depositing the material thus obtained on the bar. At low water the reverse is the case to a great extent; the bar is scoured, and the caving in the bend is materially reduced.

There are, generally speaking, two methods for the improvement of alluvial streams,—canalization and regulation.

The former, owing to the greater cost and difficulty of obtaining permanent foundations for locks and dams, is rarely resorted to, though in latter years the use of concrete has enlarged its field of possibilities.

Regulation includes two distinctive features in streams subject to overflow,—the improvement of the high-water channel and the improvement of the low or medium stage channel. In general American practice, the former consists in the construction of levees and high-water cross-dikes, and the latter in revetment and spurs for bank protection, permeable dams and training walls, sills, and dredging.

The great discharge of the lower Mississippi, the excessive oscillation of its water surface from high to low gage, the vast destructive energy expended in its flow, and the crumbling or friable nature of its banks make the problem of its regulation or improvement for the protection of property and benefit of navigation a very difficult one.

The earliest work of improvement consisted in the construction of dikes or levees to keep the flood water from town and plantation, the first of these being built at New Orleans, in the early part of the eighteenth century. It was from four to six feet high, with a crown of eighteen feet, which was used as a roadway, and was constructed of earth taken from the surface of the ground near by.

From year to year this artificial bank has been extended. Isolated levees enclosing plantations and villages have been joined to it, until there has been developed, little by little, the great levee system that will soon extend from Cairo to the Gulf, protecting nearly thirty thousand square miles of the rich lands of Missouri, Arkansas, Mississippi, and Louisiana, and guiding the floods in a permanent high-water channel to the sea.

With the exception of the constant addition to the levee lines and some tentative dredging operations at the mouth, no important work was undertaken, until the question of permanent improvement of the passes was agitated, culminating in the construction of the mattress and concrete jetties by Mr. Jas. B. Eads. As these structures were built for

* Buckshot is a black clay that resembles buckshot when in small pieces and dry.

the purpose of forming new or artificial banks rather than the protection of those existing, they will not be considered in this paper, nor can space be given to methods of improvement by means of cut-offs and outlets for relief at high water.

Stated in a few words, the plan adopted for the Mississippi has been as follows:

First, to control the flood by levees;

Second, to contract to a normal width the wide reaches by permeable dikes;

Third, to protect the banks from caving, thus making them permanent by revetments;

Fourth, to reduce the high crossing at low water by dredging.

The purpose of the revetment is to prevent the caving of the bank, and thus reduce the load of sediment that is constantly building the bar below; to maintain a normal width in the bends; to protect valuable property resting on the immediate shore; and also to prevent outlets and cut-offs, and the resulting change in the position and flow of the river.

The caving is of two kinds,—that caused by abrasion, and that caused by the combined action of seepage water and the undermining of the foot of the slope by the current, termed sloughing. The degree and rapidity of caving is governed by the material in the bank, the curvature of the bend, and by depth of channel, slope and velocity of river, and land drainage.

Brush and stone revetments have been used for many years in Europe and Asia for the protection of river banks, the custom being to employ, if possible, the material found in most abundance and procured most economically in the immediate vicinity.

The materials used for bank protection on the Mississippi are principally live willows 25 feet long by 2 to 4 inches in diameter at the butt; poles of live cotton wood or willow 25 to 30 feet long by 4 to 6 inches in diameter at the butt; rock in pieces from 10 to 100 pounds in weight, also spalls; spikes 8 to 10 inches long; No. 12 galvanized wire; manila line and wire cables of varying sizes; iron rods, hardwood pins, shackles, clamps, etc. Eight hours constitute a day's work, and the labor is paid at the rate of $1.00 to $1.25 per day, including subsistence.

It must be borne in mind that, though these structures may be similar in general form and construction to those employed on other rivers, their dimensions and the conditions under which they are placed are vastly dissimilar. No revetment work in the world approaches the magnitude of that undertaken on the Mississippi. Here mattresses with a superficial area of seven and eight acres are sunk to

BANK NEAR GREENVILLE, MISSISSIPPI, JUST BEFORE CAVING.

A CAVING BANK, GREENVILLE, MISSISSIPPI.

the bottom of the river in depths of 80 and 100 feet and in currents from 5 to 8 feet per second. Dikes 430 feet long by 60 feet high, each containing 80,000 ft. of lumber, 2,000 tons of rock, and nearly 20,000 pounds of iron (wire, rods, and nails) are similarly placed in 150 feet of water.

The early revetment work, which was purely for the protection of property in harbors and not for the general improvement of navigation (as, for instance, at New Orleans from 1878 to 1881), consisted of piles driven in pairs 6 feet apart along the bank, to which were fastened, by big iron rings, light mattresses 2 inches thick by 25 feet long and 24 feet wide, made of fish-pole cane sewed together by weaving double wires and afterwards yarn under and over them. These small mats were first fastened together, forming sections 200 by 24 feet, and then sunk with iron weights. These mats were of little permanent value. They cost from $12.87 to $7.22 per square (100 sq. ft.).

Another early revetment instanced by the work at Delta Point, opposite Vicksburg, consisted of mattresses built of willow brush and laid in cross-layers with top and bottom grillage of poles fastened together with hard-wood pins, No. 10 wire. These mats were constructed on floating ways (a barge with inclined skids), and were 50 feet wide, 150 feet long, and 2 feet thick. When finished, they were launched into the river, and sunk with the long axis normal to the bank by throwing stone on them from small barges. One of these mats could be made and sunk in one day with the untrained labor then employed. Their cost per square was $12, and per lineal foot of bank protected $18.

A modification replaced the grillage of poles and the connecting pins by a wire netting. This netting was formed on a drum attached to the weaving barge or ways, and on it was placed the brush, and, above the brush, wires which were connected through the mat, forming a very compact and strong revetment, some of which lasts to the present day.

The work thus far described is submerged; it was placed in the low-water season, and, after being sunk, remained constantly under water.

It was at first supposed that protection below the low-water line would secure the upper portion; but it was found that the upper bank quickly washed down, and in many places the mats were flanked by the current. In order to prevent this destruction and make the revetment complete and effective, the upper portion of the bank was graded by hand, and on the slope was placed a shore mat built of grillage and brush, bound by hickory pins and wire, covered with rock, and connected at the water-line with the sub-aqueous work.

BALLASTING WOVEN MAT PRIOR TO SINKING.

SINKING A WOVEN MAT.

With the promotion of river and harbor work the duty of revetments was materially extended; instead of protecting harbor fronts in limited spaces, they were employed to retain the bank in long and difficult reaches. To meet these new conditions an entire change in construction was necessary. The woven mat was adopted, and con-

MAT SINKING; THE FINISH.

tinued to be the standard for many years, and many localities were permanently and successfully protected by it.

It was constructed by first building on floating ways a rigid head of poles, to which weaving poles were fastened at right angles. On these weaving poles, extended to the full length of the mat, was woven willow brush. A grillage of poles was fastened to the top, and, after being secured to the bank and mooring barge, the mat, 400 feet long by 150 feet wide, was sunk by means of rock thrown from barges.

SLOPING THE UPPER BANK WITH HYDRAULIC GRADER.

After sinking the mat, the upper portion of the bank was graded to a slope (3 horizontal, 1 vertical) by the hydraulic method. The grader consisted of a large duplex compound pump, with a capacity of 2,000 gallons per minute, giving a water pressure of 160 pounds with a steam pressure of 80 pounds per square inch and a vacuum of 26½ inches. It rested on a house barge. The hose from the pump terminated in a 1¼-inch nozzle, from which the water was directed against the bank, reducing it to the required grade. The excavation of one cubic yard of earth took a fraction less than one cubic yard of water, and used three pounds of coal.

DETAILS OF HYDRAULIC GRADING.

Owing to the heterogeneous consistency of the bank, the slope, as left by the hydraulic grader, was often very unsatisfactory and rough. This had to be remedied by hand, sluice, and scraper dressing, before revetting. The height of bank graded averaged about 30 feet, and the material excavated per hundred feet about 3,500 cubic yards, costing about 4 cents per cubic yard for removal.

When the bank was dressed, a revetment of two layers of brush with pole grillage above and below, fastened with wire and spikes, was placed thereon and well covered with stone.

This type of bank protection, with numerous modifications, has

FINISHED BANK WITH POLE GRILLAGE AND STONE PAVING.

been used up to within a few years, and has proved in many places very successful. The size of the mattress was considerably increased, being as much as 2,000 feet long and 300 feet wide. The thickness was also increased by overweaving and cross-weaving, and the additions of loose brush under top grillage. Greater strength was obtained by the introduction of iron rods, longitudinal and transverse cables, and hard-wood heads. In the early and insufficient work the cost per lineal foot of bank protection was $14; the later standard-woven mats, 300 feet wide, with paved bank, cost $30.

Notwithstanding the fact that additional strength and thickness had been given the woven mat, it was found that the water would scour the bank through the spaces between the willows, and, owing to its stiffness, the mat was often damaged at the outer edge where the action of the current was most violent. To prevent this, and to obtain a structure both stronger and more pliable, the fascine form was tried, and proved so superior to the old mat that it has been adopted as the standard, and bids fair to solve the problem of permanent protection at all points in all materials.

The fascine mat is made with about the same dimensions as the larger woven mats, 300 feet by 1,000 feet. It is constructed in the following manner:

First, a large head of hard-wood poles, 3 feet in diameter, is formed on the ways normal to the bank. To this head is fastened, at intervals of 8 feet, a 5/16-inch wire cable, and a ¼-inch wire strand. Fascines about 11 inches in diameter made of bundles of willows are then placed parallel to and against the head, being forced well up to it and held in place by a turn of the wire strand and a clamp on the under cable. When ten feet (in length of mat) of the fascines have been placed, a second hard-wood head is constructed, taking the place of a fascine, and clamped in the same manner. These two heads form the head of the mattress, to which the mooring and shackle lines are attached, as well as the cables and wire strand. After the head is formed, the fascines are made and clamped into position so tightly that no spaces are left; indeed, the work is so compact that it will gradually sink from accumulation of silt. Transverse cables are also used, strengthening the mat and connecting it at intervals with the bank. On the top of the mattress are placed longitudinal poles fastened every 5 feet to the fascines with No. 7 silicon bronze wire. After completion, the mattress is first ballasted, by loading it with rock carried in wheelbarrows until its flotation is nearly destroyed; then

CONSTRUCTING FASCINE MAT ON MATTRESS WAYS.

it is sunk in the usual manner, by floating barges over it and throwing rock on it, in large quantities, by hand.

In the later work the upper bank is graded to a slope of 4 to 1, and on it is placed a pavement of rock and spalls carefully laid, instead of the willow shore mat, which is destroyed by natural decay in about three years.

There is a marked difference in the kinds of revetment that have proved successful in the river above the mouth of Red river and below, due to the fact that, below, the slope and width are less and the average depth greater. No obstructive bars or crossings occur, the caving

FASCINE MAT UNDER CONSTRUCTION.

is comparatively slight, and the range from high to low water at New Orleans is but one-third that at the mouth of the Arkansas. The velocity of the current at low water is very slight, and the radii of bends much greater as a rule. Interrupted revetment and dikes can be used in the lower river with much better results, and much weaker and lighter structures can be made effective.

It is in the vicinity of New Orleans that the first submerged crib dikes were placed as a protection to the city front. They were located at intervals of about 500 feet, being placed on foundation mat-

FASCINE MAT COMPLETED, READY FOR SINKING.

A PAVED BANK.

SINKING FASCINE MATTRESS; NEW ORLEANS.

tresses at first woven, afterwards of the pin and frame type. The foundation mattress was generally about 350 feet by 200 feet, with long axis normal to the bank, sunk between mooring barges with rock. The number of cribs composing the body of the dike varied with the depth of water and conformation of the subaqueous slopes.

The cribs were made of sawed timber frames, connected by long iron bolts and wooden posts fastened with wooden pins, between which and forming the body of the crib was placed willow brush, pockets being left in the construction in which to place the rock for sinking. The mattress required about seven pounds of rock for each square foot of surface, the cribs about seven pounds for each cubic

SYSTEM OF CABLES HOLDING MATTRESS DURING CONSTRUCTION.

foot of structure. The cost averaged about $7.60 per square foot for mattress, and 3¾ cents for crib per cu. foot. In the upper river, the crib work is carried to the top of the bank by framed structures similar to the submerged portion; in the lower river, by an earthen levee paved with rock.

Chief among the difficulties to be contended with in the work are the drift and snags. As the bank caves in the wooded reaches, it carries into the water large trees that for a long time remain upright in the river, forming snags over which it is impossible to sink mattresses. These are removed by powerful snag boats and explosives manipulated by divers.

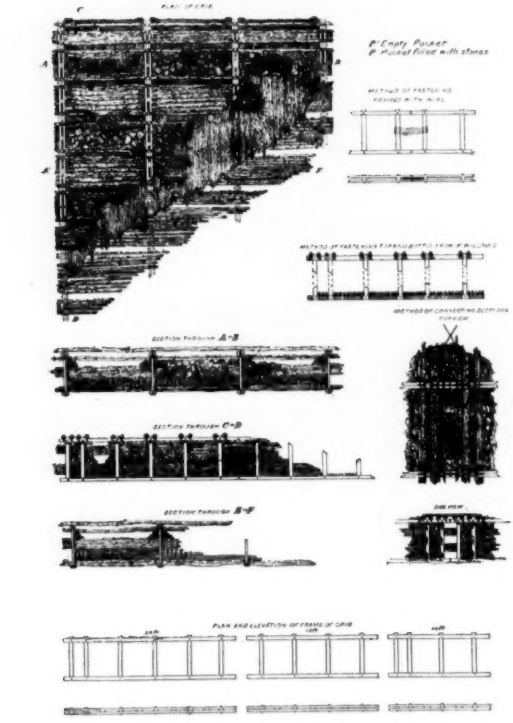
A DRIFT-PILE ABOVE THE MOORING BARGES.

When a partially-constructed mattress, say 300 feet wide and 800 feet long, is in the water at the time of a rapid rise, much drift will accumulate at the upper side of the mooring barges, necessitating the use of great numbers of mooring cables. Sometimes the pressure becomes so excessive that it is impossible to contend with it, and the mattress is torn from its moorings. The pressure in a current 8 feet per second against a mat head extending 300 feet out into the river with drift lodged under it to a depth of fifteen feet is very difficult to counteract.

In the foregoing description of bank protection two distinctive

SUBMERGED SPUR DIKES

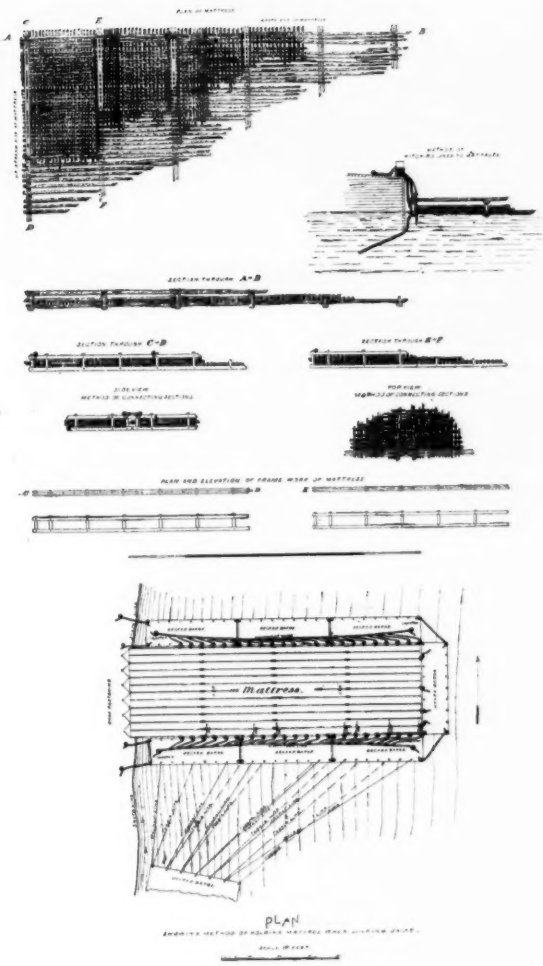
Scale of Feet.


P Empty Picket
P Picket filled with stones
SECTION THROUGH A-B
SECTION THROUGH C-D
SECTION THROUGH E-F
PLAN AND ELEVATION OF FRAME OF CRIB

CRIBS PLACED ON MATTRESS.

MATTRESS

SUBMERGED SPUR DIKES



SPUR CONSTRUCTION; GREENVILLE, MISSISSIPPI.

types of construction have been noted,—continuous revetment and submerged spurs. The former offers little resistance to the flow of the water, but the latter cause reverse flow and the checking of the current, thus producing a deposit in the unprotected intervals, when effectual. In bends of great radius, light currents, and strong bank material, the spurs have proved very beneficial and permanent, placed at intervals of about 500 feet; but in abrupt bends in light soils, even at reduced distances, they are unsatisfactory. Unlike the continuous revetment, they obstruct the inshore channel, offering resistance to flow and changing the mechanical forces of the river from potentiality to active work which, if strong enough, means destruction of the structure or the bank beneath it. In some localities in the upper river they have been destroyed, or have sunk into pockets formed by the current, and the unprotected spaces have been attacked, necessitating the application of continuous revetment.

The following table gives the materials used and the cost of dikes and standard revetments, used at the present time below Cairo.

MATERIALS.

Kind of protection.	Brush cords.	Poles cords.	Stone cu. yds.	Wire lbs.	Cable lbs.	Spikes lbs.	Cost.‡
* Woven mat per lin. ft.....	2.025	0.41	6.14	22.97	13.6		$29.07
† Fascine " " " "	4.48	0.17	7.76 Tons	11.50	36.04	3.7	30.04
Crib Dikes " cu. "	0.44	0.24	0.55	0.12	0.007		3¾c.

* Mat 250 ft. wide stone pavement.
† Mat 300 ft. wide stone pavement.
‡ Cost includes labor.

The early mats cost per square	$12.00	approximately.
The standard-woven mats per square	4.50	"
The frame mats, New Orleans, per square	9.00	"
The fascine mats, " " per square	6.00	"
Brush shore revetment, New Orleans, per square	6.00	"
Pavement, per square	10.00	"
Crib work of dikes per cu. ft.	.04	"
Grading with hydraulic grader per cu. ft.	.04	"

To build and sink a fascine mattress 300 feet wide requires from 250 to 300 men, and the average progress per day is about 150 lineal feet. Of the finished cost, about forty-five per cent. represents labor and fifty-five per cent. material.

The results obtained by bank revetment vary so in different localities, under different conditions, that it is difficult to give an intelligent idea of what has been accomplished as a whole. The early work has been to a great extent experimental, and in some localities valueless. Most of the heavy work, put in after the operations passed the experimental stage, still remains; and it is the author's opinion that, with the later forms described, a total expenditure of less than $30 per lineal foot will secure a protected bank which will withstand the wear and tear of the current and reduce the bar accretions, thus increasing the depth on the crossing and effecting an improvement in the low-water navigation.

A thorough and continuous revetment of the bank of the Mississippi, accompanied at first by the work of powerful dredges on the bars at low water, and the perfection of the levee system, will give uninterrupted and deep-water navigation.

MINOR MINERALS OF THE UNITED STATES.

II.

By David T. Day.

IN the preceding article, aluminum, mica, platinum and precious stones were discussed as native mineral products of differing interest and economic importance.

Asbestos. This substance is eagerly sought in this country and has been found in hundreds of places in the Appalachian rocks from Vermont to Georgia and in many western localities, but not a single well-established mine is in operation to-day. The main reason for this is the great supply of crysotile in Thetford and Coleraine townships, Quebec. This mineral is always referred to as asbestos, but is really a fibrous serpentine. Any mineral with a silky fiber is apt to be called asbestos; in fact, the writer has just received a sample of pure silica which was supposed to be asbestos because, under the microscope, it shows a fibrous structure which it probably acquired from the matted plant roots in which it was found.

Crysotile surpasses asbestos proper for all practical purposes. It is incomparably tougher, and admits of spinning and weaving to an extent which would be out of the question with real asbestos,—the latter being a fibrous variety of hornblende which is easily distinguished by being anhydrous, while crysotile has from ten to fifteen per cent. of water. Unfortunately most of the asbestos thus far found in the United States is real hornblende asbestos. Its fiber has proved brittle, though good enough for pipe coverings and similar things, where great strength and toughness of fiber are not essential. For these minor uses several deposits afforded a small product for years. Most interesting among these was a pocket of very good material (compared with the long Italian fibers, or, indeed, with any Canadian), found on Long Island, not far from Brooklyn. The pocket was exhausted and soon abandoned. The best promise of good supplies comes from the finds at Sal Mountain, Georgia, and another find in Wyoming, which is more like the Canadian than anything else yet found. The serpentines in western North Carolina should be carefully studied, as well as the similar rocks of California and Oregon.

Manganese and Chrome Iron Ore. For the higher grades of these substances there is a demand greater than the supply. These materials have in common the habit of occurring in pockets of greater

or less size, but with an exasperating lack of persistence. The somewhat prevalent idea that we have very large supplies of manganese in connection with the Lake Superior iron ores and in well-known beds in the neighborhood of Batesville, Arkansas, and in Virginia, must be modified by the fact that custom has limited the demand to ores which are tolerably rich; that is, the percentage of metallic manganese must be about forty-four per cent. For many purposes this rules out the Lake Superior supply and much of the material from Arkansas. Virginia has supported the manganese industry for many years, and considerable supplies have also been furnished from Cartersville, Georgia, but the richer pockets have been exhausted as fast as they were found, although the great Crimora mine was a pocket of so unusual size as to furnish more than half of the total product of the United States for several years. Our lack of rich manganese ores would have compelled us to lower our standard and use the poorer ores, and even the manganiferous iron ores which are abundant in Virginia and in other parts of the country, except for the fact that Spain and, more recently, Cuba have come forward with high-grade supplies, which can be imported more economically than we can use lower-grade domestic ores.

Our manganese mining industry began with the foreign trade to supply the chemical industry of Great Britain. The very richest pyrolusite of Virginia was shipped in barrels to Liverpool for use in the manufacture of chlorine, but this trade was later injured by two conditions: first, the Weldon process for the recovery of the manganese, so that it could be used over and over again; second, the discovery in Nova Scotia of pyrolusite, which could be shipped in pure condition without any considerable purification, and which now controls the chemical trade.

Since the disturbing influence of the civil war many efforts have been made to regain this trade by producing a still purer material by very careful concentration of Virginia pyrolusite. The most interesting of these was the well-directed effort of Mr. Miller in Baltimore, who, working on a comparatively finely divided pyrolusite occurring mixed with clay in a large and unusually persistent deposit on the James river, was able to present to the European market pyrolusite of unequaled purity. But on the death of Mr. Miller the project was abandoned.

Practically all of our manganese now goes into the manufacture of spiegeleisen and ferro-manganese for the bessemer steel trade, and, with the western extension of this industry, the manganiferous iron ore of the Lake Superior region will no doubt be used more and more.

Manganiferous iron ores associated with the silver-lead ores of Leadville have also come into use, and will increase in importance with

western development. Another source of manganese, which adds with considerable steadiness to the supply, is the residue from the manganiferous zinc ores in New Jersey, which will always constitute a well-developed factor in the supply. The total output, which in 1894 had fallen to 6308 long tons, rose in 1895 to 9547 tons valued at $71,769, the increase being due to developments in Georgia and some old producing states.

The chrome iron ore industry, like that of manganese, began in the United States with the production of an article for export to England, Scotland, and elsewhere; but it soon built up the manufacture of potassium bichromate in Baltimore, so that the factory there monopolized for many years the production of that substance in the United States. The efforts to compete with this enterprise may be counted not only by tens, but hundreds; only one, however,—the Kalion Chemical Company, in Philadelphia,—has succeeded. Foreign chrome iron ore makes the bulk of the raw material for both of these works, because the rich deposits in Maryland and Pennsylvania, which long served as the source of supply, have been worked out, with the exception of small reserves of unknown quality. Production then developed in northern California, and very many deposits of all sizes have been developed along the Coast Range from Del Norte county to San Luis Obispo. There was great demand for this material so long as the percentage of chromic oxid was above fifty, but the rich deposits were comparatively soon exhausted. Opportunely others were developed in Turkey by the investigations of Prof. J. Lawrence Smith. These ores continue rich in quality, and are transported at low freight rates. As the great cost of the process is in the decomposition of the ore, it pays to decompose only the richest that can be obtained, especially as these are more easily treated than the poorer ones, and yield, of course, higher results. Meanwhile, the keenest search is kept up for new deposits in this country, with fair prospect of success when more shall be known of the serpentine areas in the southwestern part of North Carolina and the adjoining region in Georgia. In fact, any large bed of serpentine may well be explored for chrome iron ore. The most promising of recent developments is the deposit recently explored in Coleraine township, Quebec. Possibly the lower grades of chrome iron ore will be resorted to, if the use of chromium in the manufacture of steel increases. The California production in 1895 amounted to 1740 long tons.

Sulphur. This, too, is a mineral which has been mined in the United States in a small way, and for which there is a great market whenever a convenient source of supply is developed. The supplies thus far found have been located in inaccessible regions of the west,—

in southern Utah and Arizona, and, in small deposits, in California; even in San Francisco, it is cheaper to import sulphur from Sicily or Japan. Lately, however, another deposit has excited much interest, although it is extremely inaccessible by reason of a bed of quicksand which covers it. This is at Sulphur City in south-western Louisiana. The ingenious process of Mr. Frasch, by which the sulphur is to be melted by hot water under ground and pumped to the surface, is being watched with great interest. The sulphur produced by this process must be cheaper than that which we import, and, while there is a great demand for sulphur in the United States, which is well supplied from Sicily, the possible success of this pumping method means a terrible loss to the Sicilian sulphur miners, who are none too prosperous with sulphur at its present prices. Their condition has not been improved by the Chance process for the recovery of sulphur from the Leblanc soda process. 1800 short tons of sulphur were produced in the United States in 1895.

The other chemical minerals—salt, phosphate rock, limestone for chemical purposes, borax, gypsum, pyrite, barite, and fluorspar—form a class of which the supply could at any time be increased.

Rock Salt. The distribution of large and easily-mined deposits of rock salt and salt brines is so plentiful that the process of selection has already partly excluded many of the poorer ones from the market, including the oldest member of the salt producers, Syracuse. This salt has already suffered in the decline, having been replaced by the saturated brines obtained from the rock-salt deposits at Warsaw and by the strong Michigan brines. In addition to these vigorous competitors, the rock-salt beds of Kansas are actively competing as a western supply, and in Cleveland a plant of particular efficiency is obtaining saturated brine from a deposit of rock salt underneath that city. In the meantime the rock-salt deposits of Petit Anse, Louisiana, have been reinforced by the discovery of a very thick deposit of rock salt on Orange Island. Besides this, we know of very extensive stores of rock salt for the future in south-eastern Arizona, in addition to the store in Salt lake itself. The Pacific coast is also independent of eastern supplies through the evaporation of the salt brines from the Pacific and the rock salt of the southern part of the State. It is strange that no more active search has been made among these rock-salt deposits for the discovery of deposits of potassium salts,—an industry which the United States lacks altogether, and which is limited practically to the potash beds near Stassfurt, Germany. We know so little concerning the salt deposits of the United States as to make it very possible that borings to the bottom of the larger of these may easily reveal beds of potash salts of equal importance with those in Germany; so far abso-

lutely no such bed has been found in this country, but search is now beginning.

Nearly all the salt produced, with few exceptions, is almost pure. Still, a claim for existence has been made, with success, for two brands of salt on account of their exceptional purity. There are few commercial substances which are as pure as commercial salt; nevertheless, small traces of calcium chlorid and magnesium chlorid and sulphate make a vast difference as to whether the table salt will cake or not, and salt as nearly chemically pure as it will ever be profitable to make has lately been placed on the market. It is so free from calcium chlorid as to give only the slightest cloudiness to a solution of ammonium oxalate. The undoubted effect of all this will be to raise the grade of all dairy salt.

Phosphate Rock. This is a conspicuous example of a drug on the market, though in this case, in contrast with salt, the question of quality enters largely. There is still sale at remunerative prices for the highest grade of phosphate rock, such as the hard white phosphate produced in Florida, of which the quantity is undoubtedly limited as compared with that of other grades. While the Florida and South Carolina phosphates were struggling for supremacy, a third disturbing element was introduced,—the black phosphate rock of Tennessee, which, since its introduction, has, in spite of unfavorable location as regards freights, been received very favorably on account of the ease with which it yields to chemical treatment; it undoubtedly is in the market to stay. This phosphate rock is one of the surprises of the last few years, since it occurs in the Devonian system, whereas the phosphate rock which has heretofore supplied the United States is from very much younger formations. It occurs in a belt from two to eight feet thick, which comprises all there is of the Devonian in that region. This has led to a suggestion from Dr. C. Willard Hayes, of the United States Geological Survey, that it will be well to look for phosphate rock in other localities where, as in Arkansas, the Devonian formation exists in a very thin strip, corresponding to the thicker Devonian black shale of east Tennessee and Kentucky.

Another surprise was the discovery of phosphate rock a few months since in the Tuscarora valley of Juniata county, Pennsylvania, where, in the neighborhood of Reed's Gap, phosphates undoubtedly exist; it remains for the exploratory work of this spring to determine their value. This is sufficient to indicate that we know practically nothing of the geological conditions under which phosphate rock may be found in the United States, and leaves it an entirely open question how many large fields remain to be found, particularly in the less known regions of Arkansas, Indian Territory, and Texas.

Borax. This is the only soluble salt characteristic of the arid regions that is found commercially developed in the United States. It is true that, in addition, there have been frequent commercial ventures in the production of sulphate and carbonate of soda, and even attempts at producing potassium nitrate and sodium nitrate where indications of these substances have been found in the extreme south-west. But the conditions require exceptional diligence and perseverance for the survival of any of these industries, and borax alone has succeeded. The many illustrated articles which have appeared in current literature indicate the difficulty of first refining this material from the borax marshes of western Nevada and eastern California, and then making the long haul across the Mohave desert to railroad transportation. The industry has also had to battle with very active foreign competition, intensified by new discoveries in Tuscany and other European developments, and with unfavorable tariff legislation. Nevertheless, it succeeds. We can count upon ten million pounds of borax from this country with moderate certainty. In 1895 the production was 11,918,000 lbs., worth $595,900.

Gypsum and Barite. These are substances of which supplies beyond the normal demand have been discovered, and which depend for their existence, especially in the case of barite, on uses so questionable as to make the industry's condition precarious, although the results which have been obtained with barite in place of white lead, where the latter is not useful as paint, give this substance a permanent good standing in public opinion for special uses. In both of these industries the trade is again divided between domestic and foreign supplies, but with a continually better hold on the market for the domestic articles as the producers grow in strength.

Fluorspar. The production of fluorspar in the United States, amounting to 4000 tons in 1895, has been limited by the lack of a market, in spite of the advantage of its use in foundries as a desirable flux in remelting iron. Its use, however, in the production of hydrofluoric acid increases continually, although it is difficult to ascertain, or even imagine, what becomes of the considerable quantity of hydrofluoric acid daily produced. It is not accounted for by the increasing sales for etching glass-ware, or in any other way.

Fuller's Earth. The most remarkable evidence of the ability of the United States to respond quickly to an extended demand has been the adaptation of the clay, "Fuller's earth," in the place of animal charcoal, as a filtering medium for oils and other substances. No sooner did the demand for the imported article (which has been used in this country for years for the ordinary purposes of Fuller's earth) increase to any extent than large deposits were immediately discovered

and put into service in this country. The main source of supply thus far has been Gadsden county, Florida, in the neighborhood of Quincy. Two companies are already engaged in the active production of this clay, notwithstanding the fact that it has been in use hardly more than a year. Their output was 6900 tons in 1895. It is a case of replacement of one substance by another, so that refiners, in practically discarding animal charcoal, have decreased its market value fully a third within a year. Further deposits of this material are known in southern Georgia as a northern extension of the deposits in Gadsden county, and indications of its presence are already sufficient to make it probable that comparatively enormous quantities will soon be produced, keeping this substance in the class of minerals of which there is a large over-supply.

Bromine. This is an interesting product which may at a moment's notice change from a condition of over-supply to one of great demand, on account of the experimentation now in progress to test its value as a disinfectant and also as a partial substitute for chlorine in the extraction of refractory gold ores. In the latter direction it is in connection with chlorine, rather than as a substitute for it, that it will probably go into use, and a number of recent patents in Germany and England for the quick and economical recovery of the bromine used make it probable that an enormous use for the substance will be found in this direction. Meanwhile, its adaptability for disinfecting purposes has been well proved by the Jacksonville epidemic of yellow fever. Fortunately, however, the demand in this direction is limited by the lack of epidemics, and, while very much disinfecting could be carried on to advantage at all times, it can not reasonably be expected that such will be the case until, through fear, the public is forced to it.

Nickel. The curious condition of the nickel industry is worth dwelling upon for a moment. It belongs in this same category of over-supply, where it was put by the development of the nickel mines of Sudbury, Canada. We produced, in 1895, 10,302 lbs. worth $3091, and in spite of the simultaneous increase in the use of nickel due to the preparation of nickel-steel, the quantity has kept well in advance of the demand, with the result that nickel has decreased about half in price in the last two years, without corresponding increase in its use for the old purpose of nickel-plating, etc. Undoubtedly much more steel will contain nickel in the future than in the past, and it would not require any great extensions in this direction so to increase the demand for nickel as to restore the old price, for in the steel industry the price of the nickel has little to do with the amount used; it is purely a matter of benefit to the steel, although,

after this benefit is thoroughly established, it will be some time before the iron masters will generally adopt it.

Cobalt. The supply of cobalt in the United States, (14,458 lbs. in 1895) follows the nickel product. It is typical of a mineral which depends for its development upon that of a more important neighbor, —in this case, nickel. At present the production of both nickel and cobalt is a minor feature in the more important lead industry, there being an accidental occurrence of nickel and cobalt in small quantities in connection with certain lead ores in Missouri, from which it can, fortunately, be taken out in the form of a spiess; otherwise, both the nickel and cobalt industries are dead in this country. Great search has been made for nickel ores in the serpentine rocks of the Appalachian system. In Nevada, near Lovelock's station, deposits of cobalt and nickel arsenid have been found, and in Oregon nickel silicate similar to the garnierite of New Caledonia. But, after the more or less careless methods of exploitation, we are not yet in a position to state whether the deposits are workable or not. Very recent is the discovery of metallic pebbles of nickel and iron, which were at first supposed to be meteorites, in placer ground in Josephine county, Oregon. From the county they have taken the name of josephinite. To discover the source of these pebbles and of a supply of nickel has been the object of much prospecting, but with no result.

Corundum and Emery. These substances are typical of a class of minor minerals in which the trade is dominated by foreign supply and in which the domestic product has been continually obliged to struggle against a well-established import trade, although the native mineral far outranks the foreign in quality. The production of emery in the island of Naxos is very ancient, and the importation of material from Greece received a new impetus by the discoveries of magnesite, chrome iron ore, and emery by Prof. J. Lawrence Smith in the neighborhood of Smyrna and Ghimlek. The essential conditions which make it possible for these Smyrna deposits to practically dominate in the supply are, first, that all three of these articles are found together, and, second, that the conditions of occurrence are such as to admit of easy mining. The labor, which is very cheap, suffices for the industry there, though it might not elsewhere. Nevertheless, this foreign emery, which has only from forty to fifty per cent. of the hardness of the best material found in this country, must eventually give way as recognition is obtained for the superior quality of the products which we can obtain at home. The condition is a complicated one on account of the steps necessary in exploiting the deposits of ore: selecting the best of the materials and carefully separating them from softer accompanying minerals; then turning the whole product over to another line of

business, which has been the sizing and sale of emery sand; and then to a third set,—wheel-makers. This is too long a series of processes for the final user of the wheels to grasp, and he has relied simply upon the cheapest wheels which would give efficient results. The average user is entirely unacquainted with any exact standard of merit for the wheels, and is not capable of appreciating the distinctions which must be made when easy and accurate methods of estimating the abrasive capacity of corundum and emery come into common use. As it is, in addition to the emery plentifully found at Chester, Massachusetts, and in Westchester county, New York, and the corundum of Chester county, Pennsylvania, and of similar serpentine belts already mentioned (which run with great persistence for one hundred and fifty miles or more parallel with the Blue Ridge and about ten miles from the summit on the north-west side), corundum of all varieties of hardness can be obtained, from nearly pure sapphire to corundum of inferior quality. The direction given to prospecting by the fact that this corundum usually occurs on the line of contact between these large dikes of serpentine and the inclosing hornblende gneiss will certainly lead to the development of many more deposits in North Carolina and Georgia, and the development of a greater corundum and emery business in this country, at the sacrifice of the imports from abroad; which is fortunate, since, of the three materials,— corundum, native emery, and imported emery,—the imported emery is certainly the least efficient. The question between the value of corundum and emery is all the more an open one from the fact that the best result is largely due to the best wheel-makers; in other words, the process of making the wheels themselves can be carried out with such skill as to produce a better wheel from poorer raw material than is often made from the very best corundum.

In addition to the foregoing minerals, deposits of many others are known to exist in this country,—even of minerals which find useful applications in other lands, but for which a market has not yet developed in America; and there are others again which are matters of daily produce, but are thrown away for lack of interest in saving them or of a market when they are saved. One has but to think of the enormous aggregate quantity of such substances as arsenious oxid and others, particularly such rare minerals as bismuth and cadmium, which are continually being thrown off into the air from waste gases in western smelting works.

Among the minerals for which there is practically no market may be mentioned zircon, rutile, uraninite, gummite, ilmenite, fergusonite, samarskite, columbite, and gadolinite; and, within a few years, monazite might have been included in the number. This furnishes a con-

venient example of how considerable deposits of what was an extremely rare mineral can readily be obtained, if a demand for it is fairly well advertised. Although this mineral has been known to occur in many places in granitic rocks, and has been noticed in more than a dozen localities in the United States, besides the present sources of supply in North Carolina and South Carolina, as well as in Canada, South America, England, Sweden, Norway, Russia, Belgium, France, Switzerland, Germany, Austria, and Australia, it was one of the very rare mineral curiosities when that enterprising economic mineralogist, Prof. W. E. Hidden, observed its occurrence in considerable quantities in Burke and McDowell counties, North Carolina, in 1879. As soon as an economic value was established for it on account of the incandescent properties of the oxids of cerium, didymium, and thorium, which it contains, it became a commercial article. It is the thoria for which it is principally valuable in the manufacture of the Welsbach and other incandescent gas-lights. The cerium is also utilized, going into the drug trade in the form of the oxalate. The industry is a rather uncertain one, on account of the variation in the amount of thoria which the monazite contains. Thoria is there rather as an impurity than as an essential constituent, the monazite being principally phosphate of cerium, the thoria usually constituting only from three to seven per cent. of the total weight. It is curious also to notice how a number of geologists now bring forward the idea that monazite can be found in any granitic rock ; in fact, that its presence is a fairly good test as to whether a rock is granitic or not.

Finally, there is an interesting list of useful minerals which are not now mined in this country, although deposits of all of them have been described. Among them are alabaster, celestite and strontianite, pumice, chalk, alunogen, mineral soap, ozocerite, lithographic stone, hanksite and other soda minerals, ulexite, tincal, obsidian, wolfram, vanadinite, and greenockite.

Frequent projects have been evolved for using one or another of these, and abandoned usually not because of lack of supply, but from inaccessibility ; for it may be noticed that most of these are found in the unopened west, and cheaper supplies can be imported. In such cases the failure to use them, and the preservation of a supply for the future, cannot well be regretted.

QUACKERY IN ENGINEERING EDUCATION.

I.—A CRITIC'S CONFUSION OF ENGINEERS WITH ARTISANS.

By Edward H. Williams, Jr.

MR. KIDWELL appears in your May number, brimful of wrath, and, after mauling the life out of the course at Cornell, because it pretends to teach practical use of tools in the limited time that can be given to such things,—wherein he is eminently correct,—he does not stop in the safe place he has made for himself; but, wheeling diametrically about, he "sails into" the Lehigh course, because it does not contain practical work. He is not right in both cases.

Granted that life is short, and that it is of first importance that a course should end in time to allow a man to do a little practising before he dies, and granted, further, that the length of the course must be limited by the money a man can invest in it, it is required to plan an "engineering" course,—not a course for an artisan. To be an engineer one must have a thorough working knowledge of the higher mathematics. Unless the entrance requirements are at the top notch, this means that parts of two years will be necessary for its perfect acquisition. Then come the applied mathematics, experimental physics, mechanics, strength of materials, some knowledge of chemistry, and a facility in handling drawing-instruments that can come only from time, and an accuracy in their use to be obtained only from experience. Is the man to be a mechanical engineer? He must have a a thorough knowledge of thermodynamics, kinematics, fuels, iron metallurgy, and measurement of power. He possibly can get along without a knowledge of the modern languages; but he must rely then on translations, and, unfortunately, the best text-books in the science are in German and French,—preferably the former. To read these he must put in the continuous work of parts of three years, as technical German is no joke. In the time that is left he must learn all that he can about machinery,—not machines; Mr. Kidwell does not seem to know the difference between the terms,—and here is where the ways diverge. If he is to know about machinery, he goes in one direction; if about machines, he will never become an engineer, but he may know all about chipping, filing, etc. Let me now tremblingly, a missionary to the heathen, and with, perhaps, a similar fate before me, preach my brief preachment.

Let me start with the axiom that the engineer works with his head, while the artisan uses his hands. The former knows by careful study

of work, as well as by comparison of good, indifferent, slovenly, and bad work, how work should be performed; what conditions govern its inception; what economic questions must be settled before its undertaking: the latter knows how to do certain kinds of work well on certain tools, and by experience becomes a "skilled workman"—and nothing more. The one looks beyond the work to the tools; their arrangement; the building in which they are housed; the motors which run them; the economy of the service, and the ultimate profit: the other moves in his little circle, knows his little stint well—and nothing more. The "engineering" school teaches the student humility, as it opens to his vision the wonderful works of the past, and shows him how small and insignificant he is in this great world, which is so old and so critical. The "shop" teaches the man the shop traditions, lets him see all that the walls contain. The man soon "knows it all"; becomes cocky and self-opinionated; comes down from his little draughting-room, in the shop of the logging road he serves, to "inspect" the work the Baldwin people, for instance, are doing for them. He cuts a wide swath for a day or two; gets all the rope needful, and hangs himself. During the rest of his life he boots himself all over that shop because he did not know enough to keep his mouth shut. The "engineering" school teaches the student that each instance brought to his attention is simply an instance; that each novel instance must be solved by comparison; that the future has myriads of such instances, no two alike, and that only by abundant practice in their solution can he hope to become expert; that he must begin at the bottom of the stair with a low salary; that he can learn something from the navvy on the spoil-bank and the wiper in the stalls. It does not waste time in giving a man a smattering of how to file square; to swing a pick; to tighten bolts on a bridge, or pound his mate's hands in an effort to hit the drill-head. The truly egotistical man is the self-made man who has worked in his little circle till the grass is worn off; the man who thinks he has invented what the nearest library would show to have been common property since the creation. This man wishes the embryo engineer to fritter away his time in learning how to perform manual labor which he will under no circumstances put in practice in after-life; which will seriously cut into the time allotted to his education; which, as Mr. Kidwell shows, can be at best but superficial and valueless; and which will make him as narrow and self-opinionated as the man of straw set up by Mr. Kidwell for chastisement.

I should much like to have Mr. Kidwell come to Bethlehem and see the results of a course approved by one whom the American Mechanical Engineers have chosen to guide their meetings, and for which such

engineers as John Fritz and the late Eckley B. Coxe stood sponsors, as trustees of the institution which offers it. Perhaps he might get a knowledge of the difference between machines and machinery, as he queries at the latter word in his sneer at the course. Perhaps, after a course of sprouts during two years in the immense works of the Bethlehem Iron Company, of daily afternoon occurrence, and weekly comparisons at Easton in the L. V. R. R. repair shops,—perhaps, I say, he might learn how a plant could be used to its highest advantage. Meanwhile I will ask him to study the article in your magazine which showed that Lehigh mechanical engineers were not afraid of low salaries, and obtained positions more readily than those with whom they were compared. Here, certainly, there is not cockiness, or a desire to "boss the ranch" at the start.

Let me further preach that the professor in charge of a course knows better the needs of the course than either the artisan or the expert. The first is constantly asked for men to do certain things; is told of new departures; is freely consulted, because his position makes him the father-confessor, from whom all think they can get advice *gratis*. What the artisan sees over the sideboards of his treadmill is not the world. The expert, to be truly one, must specialize, and thus leave broad for narrow grounds. He may be lord-paramount in his little sphere; but he must stay therein, if he is to dogmatize. It is always an unfortunate day for him, when he flops laboriously to the top of the fence and crows defiance to the world, as it shows him that security of position is nearer the ground. In the future let the critic and comparer lay down the rule followed by every engineer: study the results before going ahead. It is far easier to criticise and destroy than to build.

Mr. Kidwell is sound, however, when he attacks Mr. Thurston's estimate of an endowment. The desire of Johns Hopkins that his money should be invested in brains rather than bricks and mortar should be pasted in the hat of each educator. The right man will find the illustrations. The chemical work which laid the foundations of chemistry and discovered the elements was developed in a kitchen-sink with the stems of tobacco-pipes.

II. THE BROAD VALUE OF A TECHNICAL TRAINING.

By D. C. Jackson.

THERE can be no difference of opinion upon the importance to engineering students of a taste for the study of applied mathematics and applied mechanics as well as a readiness with eye, ear, and hand; but,

above all, success upon the part of such students is dependent upon a love of hard, consecutive work. The fact that many students who have not the gifts required in the engineer's profession have been attracted to the engineering schools and have continued in ill-adapted courses to graduation has led to much pessimism in regard to the supply of, and demand for, young engineers. The engineering schools, however, have never yet caused an over-supply of sensible, hard-headed young men with a first-class training of their faculties,—young men having a useful knowledge of applied mechanics at their fingers' ends,—and they never can cause an over-supply of such young men until the country has reached stagnation and ruin. The welfare of the country is indissolubly bound up with the continuance of the industrial life which has been brought about by engineering knowledge and invention.

Of all the immense wealth held by the individuals of this country, the enormous proportion of between one-fourth and one-third is directly employed in operations dependent for success upon engineering knowledge and skill, and much additional public money is invested in improvements made possible through the skill of the engineer. This points conclusively to a great demand for well-trained, conscientious engineers, and the demand is proved by an examination of the employments of the graduates of the twenty or twenty-five first-class engineering schools of the country. It also points to the importance of a general dissemination of engineering knowledge. We seldom hear the claim that a legal training is wasted on a business man, and there is no ground for the claim that an engineering education is wasted on any man who has a responsible connection with industrial enterprises. Indeed, there is good ground for the claim that an engineering college course is one of the most satisfactory preparations for the life of the average man, since it tends to enliven his intellect and strengthen his resources where strength is most needed.

It is not to be expected that engineering students will obtain lucrative employment immediately upon graduation, or, indeed, that all will go directly into engineering occupations. The proposition that the engineering schools shall make finished engineers is absurd, and it is unreasonable to expect that graduates will be taken at once into the confidence of their employers, or be placed, immediately after graduation, in positions of responsibility. It is natural and proper to look with suspicion upon the capabilities of the medical graduate, however fine his college training, until he has spent considerable time and gained much experience in hospital service or in practice under the direction of an experienced physician. The legal graduate also serves an apprenticeship as a law clerk, before he is entrusted with important duties. In the same way the engineering graduate must prove his

worth in a subordinate place, before he is entrusted with responsibility or with confidential affairs. Forgetfulness of this universal fact leads to many heartburnings and much pessimism on the part of new graduates, some of which finds its way into articles in the technical journals. Nor can we judge of the usefulness or success of engineering schools by canvassing the positions held by the members of the last class graduated. If all graduates of a few months' standing were found to be in places of more or less responsibility, it would be fair proof that their instruction in the engineering schools had been devoted too exclusively to a superficial instruction in "engineering practice" rather than to a properly-balanced proportion of principles and practice. The former doubtless gives the graduate the better chance to "get a good position" at once, but it leaves him with a lamentably weak foundation upon which to improve the position. The true way to determine the usefulness of engineering schools is to examine the registers of their graduates during the past fifteen years (or, better, for twenty-five years past), and from them determine the proportion who have made marked improvements in the industries, have materially advanced the welfare of the land, or have won distinction in their life. A parallel examination made upon this basis of the graduate registers of the colleges of engineering, medicine, and law, and of the so-called humanistic courses, shows results greatly to the credit of the engineering schools, and conclusively proves that engineering education is not overdone. Such an examination points so clearly, indeed, to the ample advantage gained by the country from the engineering schools as to suggest the advisability of bringing those of higher grade into closer relations to the national life, without, however, in any way weakening their local connections, which are often of the greatest utility.

III. DISAGREEMENT OF THE DOCTORS OVER THE MINING COURSE.

By H. K. Landis.

APPARENTLY, the educational and patent-medicine ponds are equally open to quacks who thrive and paddle about in peace in the undisturbed waters until a Munroe or a Kidwell calls for a reckoning; in both "the doctors disagree," not because there is any difference in the end to be accomplished, but rather because the "doctors" find it difficult to diagnose the case, and submit as a remedy some high-sounding "cure for all diseases." As Mr. Edgar Kidwell, in the May number of this magazine, shows that such quackery exists in general, we will take the special case of mining schools. Jacob's coat could not have been more varied. One church school teaches the New Testa-

ment ; a university enlarges on the French revolution and the history of Europe ; a southern school finds agriculture and military science necessary ; while another utilizes its paid dominie to give instruction in Christian Evidences ; and all to teach a youth how to make iron and steel or manage a gold mine. It may be right to fill in the foundation of an education with stumps and other rubbish, because it is handy, but we can scarcely be asked to take it for granted that it is good practice, because some Ph. D. claims that it is.

Let us look into this diversity further. From a list of 34 mining schools and courses we take the following instances, arranged according to the cause for variation in the departments of instruction, and scaled with reference to the relative time devoted to each department in a four years' course.

Dominant factors in certain schools.	Physical Science.	Chemistry.	Mathematics.	Mechanical Engineering.	Civil Engineering.	Mining Engineering.	Literary.	Miscellaneous.
Strong Chemical Dept	9	17	7	6	7	7	11	9
" C. E. "	6	3	7	7	15	3	4	2
" Mining "	5	10	5	10	5	15	4	2
" Literary "	7	11	6	3	12	4	20	5
Location near mines	4	8	4	8	6	10	..	..
A Southern college	6	7	4	7	4	5	14	2
An Australian school	4	14	6	6	4	11	..	..
A German school	3	18	5	16	11	30	5	..
Average of 34 mg. schools	4	10	7·5	7	7·5	9	5	2

There is not here a question as to which is the better, but rather a grave suspicion that some of our educators have not even the remotest idea what a professional mining engineer or metallurgist is required to know in order to follow his profession. Here are some of the subjects they require for the degree of mining engineer :

Military drill.	Elocution.	Constitutional law.
Shop wood-working	Art of war.	Photography.
Shop iron-working.	Greek.	Sanitary engineering.
Bookkeeping.	Logic.	Aerodynamics.
Civil government.	Irrigation.	Astronomy.

The list might be prolonged with compulsory chapel attendance, prizes for good conduct, etc., if space and patience permitted.

We find among the men who direct our mining schools ministers of the gospel, mathematicians, lawyers, civil engineers, scientists, and, in a few isolated cases, real mining men. The results are in accordance. It rarely happens that a good mining engineer or metallurgist of experience occupies a professor's chair for any great length

of time, as the restrictions which force him into the same groove with the teacher of history or mathematics become exceedingly irksome. The chair, as well as the profession, should be in direct contact with the latest practice; it will not answer to compile lectures from published literature, if the teaching is to be what the student needs; the student must study as much as possible the method or process on the ground. It is humbug of the highest order to grade a man as a mining engineer when he never has seen the inside of a mine or felt the heat of a furnace; and yet it is done repeatedly. Mr. Kidwell may be right in the example cited, but, if a professor of mining wants to be of value to his students, he must not only tell how a substance is mined but also what it costs to mine it, what it sells for, who buys it, how it is manufactured, the market value of the product, who consumes it, and into what article it finally goes; and this requires an intimate knowledge of and contact with changing commercial conditions. Mr. A. M. Wellington, editor of the *Engineering News*, says, "The fundamental error in all our schools is in giving too much thought to *what* is studied and too little to *how* it is studied. Choctaw, Chaldee, Egyptian inscriptions, or anything else studied in such a way as to train the mind to think and be thorough, is good," and strongly recommends experimental work. The problem, and claim made by the schools, is to educate a man that he may meet all demands made on him by his profession. This does not imply thorough knowledge, but rather a sufficient groundwork, acquired information, general culture, and mental habits to enable him to rise successfully to any occasion in his profession; and any scheme that introduces unnecessary factors in his training, or fails to do what it claims to do, is rank humbug. The end to be attained is the first thing to be considered. Mr. Eckley B. Coxe puts it: "Not knowing exactly what you want to do nor the material you have to do it with, what is the best way of doing it?" This is the precise situation; in a paper before the Am. Soc. of Mech. Eng. he says that a mining engineer may be "either a business engineer, constructing engineer, managing engineer, theoretical engineer, compiler, or teacher" but where is the school that directs its instruction according to any such classification? A few of the smaller institutions turn out prospectors, assayers, draughtsmen, surveyors from short courses, but our best schools aim toward superintendents full of theory and laboratory work, which, according to Mr. H. O. Hofman, "tends to produce theorists, who speak with unwarranted assurance concerning the most difficult problems the engineer has to solve; but who, if confronted with a simple, concrete question, are at loss what to do," and, we might add, tend to bring the profession into

disrepute. To be successful, a man must know one thing well, have particular information on adjacent lines, and a broad knowledge of men. Aside from technology, he should be familiar with mine and works accounts, the laws relating to the transfer of property, customs regulating the handling of money, the proper forms and precautions to be observed in legal papers, the systems in use in the handling and organization of employees, and, above all, the ability to write and speak his own language with correctness and fluency. And yet our mining schools will toss "the poor graduate" from their front door among the bunco men, mining sharks, silver-tongued speculators, and shrewd business men, with the direction to swim or sink, and smile at the comedy while the young man is getting his experience. The humbug lies in their claiming to have taught him the things necessary to him in his profession.

IV. PRACTICAL SCHOOL METHODS AND IMPRACTICABLE DEMANDS.

By George L. Hoxie.

QUACKERY in engineering education, as elsewhere, is something much to be deplored, and, if it can be proved to exist, we should at once bestir ourselves to get rid of it.

It is difficult, however, to understand the object of such an article as appeared in the last issue of this magazine, unless it be to convince us that those institutions which we have come to regard as the leading ones in technical education are in reality mere shams, much inferior to many obscure colleges,—their large and costly equipment useless, and perhaps, indeed, positively detrimental. From such a view the writer wishes to emphatically dissent.

It is doubtless true that the first attempt of a young graduate "to bore out an eight-foot cylinder" would probably prove disastrous. No technical school trains its students to do such heavy work, or makes the slightest pretence of doing so. Yet in all well-managed institutions the average student does gain a surprising facility in the use of small tools and in ordinary shop-processes, and it is not "quackery" to say so. Certainly one may often find specimens of students' work comparing favorably with that turned out by "old hands."

It may be that no startling discoveries have been made with the "experimental steam engines representing from $10,000 to $15,000." The ordinary graduate is, or should be, well satisfied, if he has been thoroughly instructed in the latest advances made by men who have had a life-time of professional experience. It is not to be expected

that he will begin to instruct the world before receiving his diploma. However, any candid man must admit that those schools which, through lack of funds or mistaken judgment, attempt to teach the theory and practice of compounding, jacketing, and all the many other details entering into the economy and management of modern large power units, "on an engine costing not more than $700," are at a serious disadvantage. Such instruction must savor of the note-book method of shop-practice, so strongly condemned by Mr. Kidwell.

Again, he tells us that a college is "guilty of educational quackery," when it permits its professors to engage in an outside engineering practice. From another part of the same article, one infers that the undertaking of "tests for money," and even the writing of books, and presumably of magazine article, are included in this general condemnation. It should be unnecessary to point out that able men are often secured by schools which cannot pay for the exclusive right to their services. So long as a professor renders a fair equivalent of labor for the salary received, no one is defrauded. It may well happen that such a man, by keeping in touch with practical matters, becomes better able to teach them. As to the undertaking of tests, it is surely an invaluable privilege for a manufacturing community to have at hand a laboratory in which tests of all kinds may be conducted with absolute fairness. Such testing should be considered a part of the legitimate work of every institution equipped for it.

While in some cases abuses may have resulted from allowing a private engineering practice, the writer chooses to believe that such instances as are related in the article referred to are at least uncommon. Certainly the attempt to restrict the activities of a professor as suggested cannot but be injurious in the extreme.

REVIEW OF THE ENGINEERING PRESS

WITH A DESCRIPTIVE INDEX TO THE LEADNIG ARTICLES PUBLISHED CURRENTLY IN THE AMERICAN AND ENGLISH ENGINEERING AND ARCHITECTURAL JOURNALS.

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American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
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American Magazine of Civics. *m.* $3. New York.
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Am. Soc. of Mechanical Engineers. *m.* New York.
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Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
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Architecture and Building. *w.* $6. New York.
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Australian Mining Standard. *w.* 30*s.* Sydney.
Banker's Magazine. *m.* $5. New York.
Banker's Magazine. *m.* 18*s.* London.
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California Architect. *m.* $3. San Francisco.
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Canadian Electrical News. *m.* $1. Toronto.
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Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
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Iron Industries Gazette. *m.* $1.50. Buffalo.
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Journal Am. Chemical Soc. *m.* $5. Easton.
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Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

See also "Civil Engineering" and "Domestic Engineering."

Mr. Thomas Hastings.

THE extraordinary talents of Mr. Thomas Hastings form the theme of an article by Mr. Barr Ferree in *Stone* for March, in the series he is contributing to that magazine on "Notable Stone Buildings in New York." The Mail and Express Building serves as the text. This structure is remarkable in more than one way, for, while not pleasing as a whole to look at, it bears evident marks of being the work of a scholar and an artist, and is, in a way, one of the most notable buildings in the metropolis.

Such criticism as has been directed towards it has been based on the highly-enriched and narrow Broadway front. On all hands, even by those who do not follow the classic school so admirably represented by Mr. Hastings, the larger front on Fulton street is conceded to be one of the most notable successes in commercial architecture. That the art of this front is to a certain extent applied, and in no way helps the building structurally, is more than offset by its fine proportions, its studied harmony, its refinement, and its art. Of the Broadway front Mr. Ferree tells us that its richness was demanded by the gentleman for whom the building was erected, and his architects, therefore, had no other choice than to follow his directions.

The Mail and Express Building is not the masterpiece of Mr. Hastings; that distinction belongs to his magnificent Ponce de Leon hotel at St. Augustine,—a work of marvellous merit, and the more astonishing because it was done at the very beginning of his artistic career. But, though the Mail and Express Building is not his most successful work as a whole, it illustrates, in a very marked degree, the scope of his art. Mr. Hastings's temperament is emphatically artistic, and he is thoroughly in earnest. Those who enjoy his confidence—and a more open-hearted man does not live—know that again and again he has sacrificed valuable time that he might himself carry out the wishes of his client, where a less enthusiastic man would have delegated the details to an assistant.

The love of his art spurs him on to constant effort; his enthusiasm is boundless; his scholarship and his learning, his conscientious care, his familiarity with his art, and his earnestness make an intense personality that already, at the beginning of its career, has become one of the most interesting and noted figures in American architecture.

It need hardly be said to those who have watched the artistic progress of Mr. Hastings that he is committed to the French school first, last, and all the time. But his adhesion to it is heart-whole, and the result of profound conviction of truth. Mr. Hastings is easily the most eminent practitioner of French artistic forms in America, yet he would himself be the first to deny their French character and to insist on their supreme modernity. His forms are his faith, though it is but simple justice to him to say that he would deny that he follows forms, claiming, rather, to practise principles. Whether principles or forms,—and the difference is intrinsically important,—it is of more moment to remember his abiding faith in his artistic convictions. Mr. Hastings follows the French school, not because it is a fad of the day, not because it is easier to design under its system than when every idea must be originated by the architect, not because certain grandiose effects can be obtained in French architecture more readily than in others, not even because he happened to be trained in the École des Beaux Arts, but because a deep study of architecture has convinced him of the reasonableness of his faith, its soundness, its value, and its availability in our own day.

One may not agree with Mr. Hastings in this, but it is impossible to ignore his enthusiasm, and it is difficult to resist the fascination of his art. Mr. Hastings's en-

thusiasm permeates all his work, and it does not diminish its scholarly value or detract from its refinement. And, if he sometimes, as in parts of the Mail and Express Building, does things he ought not to do, he does them with such candor, and surrounds them with so admirable art, as to compel admiration from those who cannot follow him in his chosen field.

semi-suburban character. It is generally recognized that the standard of public taste is advancing, when measured by the work done ten years since, as well as the skill of the architects; but few opportunities occur for expressing this progress, owing to the utilitarian character of many of the more important buildings.

It will be noted that this is precisely the

THE OTTO STORE BUILDING, BUFFALO, N. Y. E. A. KENT, ARCHITECT.

[From American Architect.]

Architecture in Australia.

A RATHER gloomy picture of the present condition of architecture in Australia is drawn by *The Architect* (April 17) from the annual summary in the *Year Book of Australia*. The problems presented to the architects of that continent appear very similar to those which come before American architects, the more important buildings being commercial in their nature, or else dwellings of a suburban or

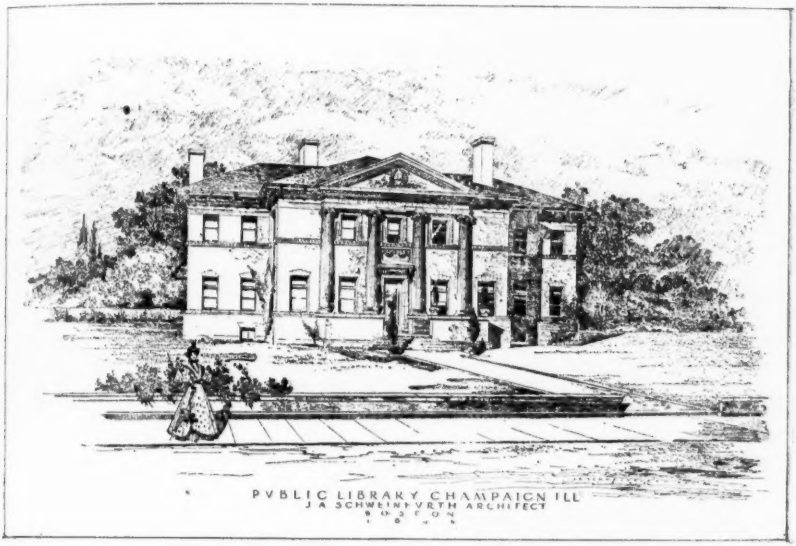
condition of architecture in America today, though here we have larger opportunities, and commercial architecture has advanced to that point where large expenditures are made for purely artistic effects in buildings of this class. The parallel between the two countries will doubtless continue for many years to come, and in both the absence of historical precedents at home must hinder rapid advances. New South Wales continues to be the seat of

the great building activity, and much is looked for from the resuscitation of the New South Wales Institute of Architects, which started afresh last year. *The Architect* states that there are few architects whose business in the past year exceeded $100,000, and that the government contracts in this colony, which the year before exceeded $1,000,000, were last year, not two-thirds of this.

Illustrations of the Month.

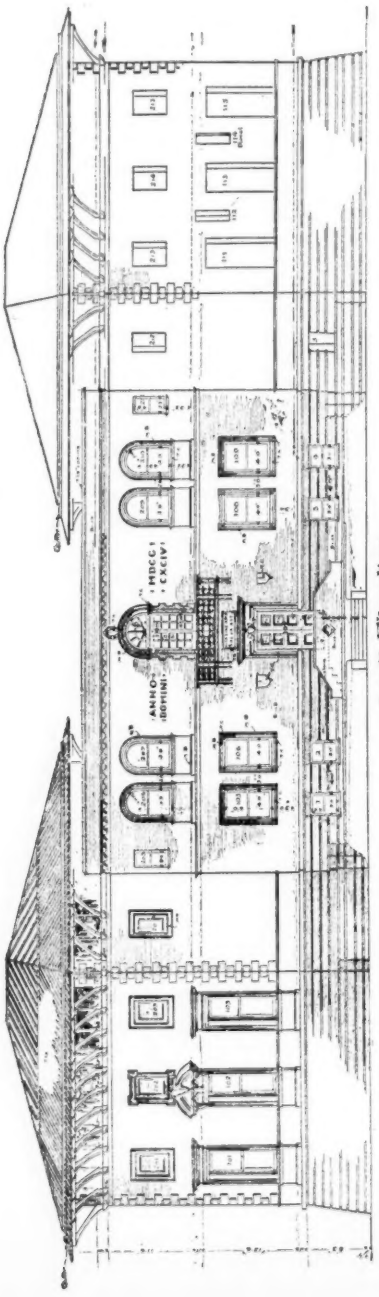
THE most important building illustrated in the April technical papers was the new design. It has an impressive front, with a pavilion at either end, whose high roofs with their rich gables admirably harmonize with the roof of the center, astride of which is a gracefully-designed cupola. The leading features of the design are a series of arches between piers below, large rectangular windows separated by Corinthian columns in the upper story, and a series of rich gables above the main cornice. It is extremely well composed, and is altogether a most interesting building.

The most admirable thing in this design is its essentially French character. It is



PUBLIC LIBRARY, CHAMPAIGN, ILL. J. A. SCHWEINFURTH, ARCHITECT.
[From American Architect.]

mairie for the tenth arrondissement of Paris, a fine photograph of which is published in *The Builder* for April 11, and elevations and details of which appear in the *American Architect* of the same date. *The Builder* likewise prints an illustration of a superb sculpture relief, entitled "The Triumph of the Republic," by M. Dalou, which is placed in one of the reception-rooms of the new building. This structure appears to be one of the most notable additions to recent public buildings in Paris, and is a fine type of modern French typically French and, one might almost say, typically Parisian. It is quite possible that this design will, ere long, reappear in one form or another, in some American building; but in such a case it will cease to have its most distinguishing characteristic. It is often contended that it is better to copy a good design than to originate a poor one, and there is a certain amount of speciousness in the assertion, though it should first be shown that it is impossible to employ architects capable of originating good designs. American archi-



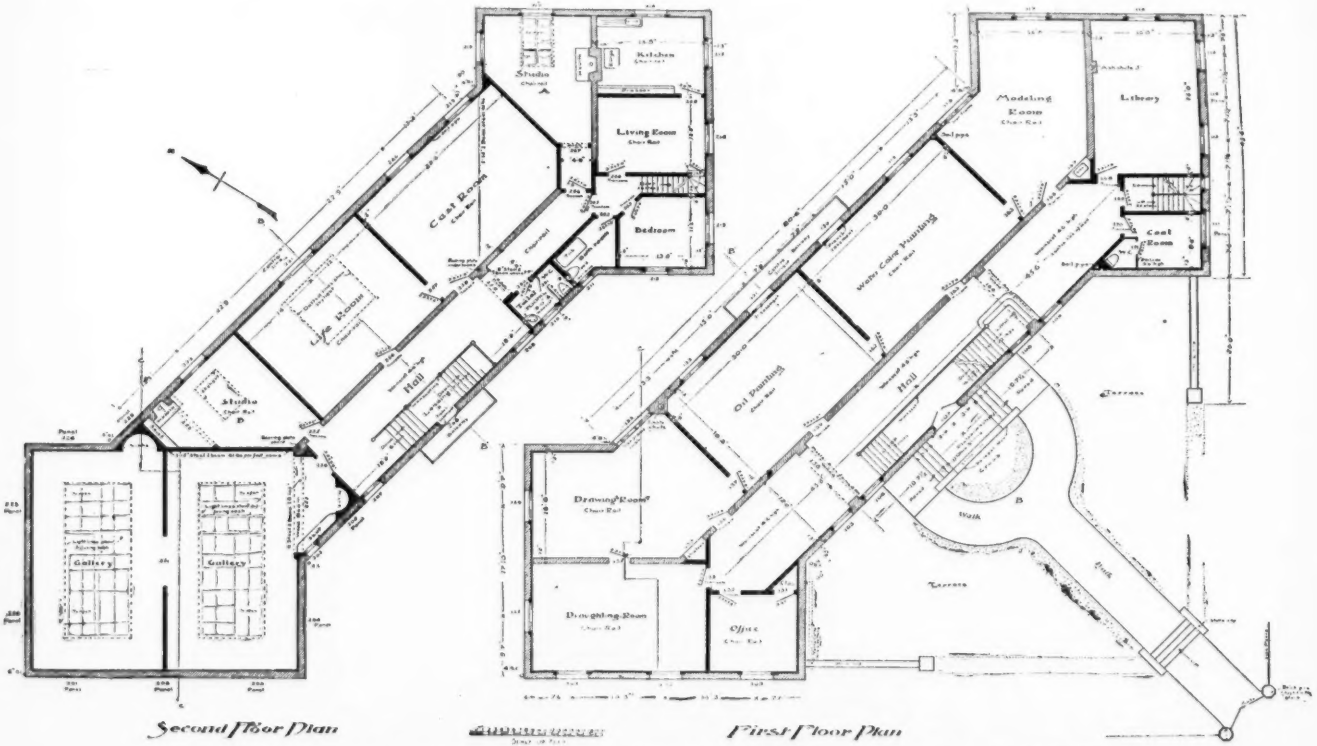
South Elevation

ART BUILDING FOR H. SOPHIE NEWCOMB MEMORIAL COLLEGE, NEW ORLEANS, LA. WILSON EYRE, JR., ARCHITECT.

[From the Brickbuilder.]

tects—or, rather, certain American architects—are at present the only class of professional men who seem to regard deliberate copying as something to be commended. A building like the new *mairie* shows what excellent things are sometimes produced by those trained in the École des Beaux Arts at home. It is only when such designs are transplanted to America that they lose their significance and become absurd.

A very different design is that for the new public library at Champaign, Ill., which is another in the long series of so-called classic library buildings now going up in all parts of the United States. It is a simple enough design and quite free from affected mannerisms, though it must be confessed that the drawing scarcely gives the impression of a library building. Much less successful in the application of classic ideas is the Otto store building in Buffalo, N. Y. There is an abundance of window space, as was necessitated by the conditions of the problem, but it is not artistically managed. Two of the main piers in the first story stand free before the entrances, and are mere props to support the vast lintel that stretches wholly across the building. In the next two stories the wall space is simplified by being suppressed altogether, Ionic columns supporting another lintel or entablature. At the third floor the wall really appears as a wall, but only for a brief space, for the fifth floor is a narrow attic, with rather meaningless circular windows. It is impossible to find here any elements of success, though there is an abundance of classic material. With this may be grouped the Hancock Building in New York (*Architecture and Building*, April 25). The proportions are very bad, for, while it is only seven stories high, the basement floors consume three of them. Ionic columns,



ART BUILDING FOR H. SOPHIE NEWCOMB MEMORIAL COLLEGE, NEW ORLEANS, LA. WILSON EYRE, JR., ARCHITECT.
[From the Brickbuilder.]

widely spaced, divide the fourth, fifth, and sixth stories into bays, and a frieze story, not an attic, surmounts the whole. The wall space is handled with considerable success, though the piers of the first two stories are narrower than that above them; but it is impossible to believe that the classic orders were in tended to be used in the way they have been in both these buildings.

Still another type of the current use of classic ideas is shown in the Art Building for the H. Sophie Newcomb Memorial College in New Orleans. It was designed by Mr. Wilson Eyre, Jr., and, while essentially classical in detail, is full of that poetry and individuality which this architect has so long accustomed us to find in his work. And this means that, while classic ideas—of the Italian Renaissance, by the way—are employed, they are used so freely as to convey no sense of copying. It is a highly original and interesting piece of design, and may be profitably studied by students of classic art in its modern interpretation. The plan is a striking one,—two rectangular pavilions connected by a diagonally-placed center, an arrangement which gives a delightful variety to the silhouette and adds materially to the success of the design.

An extremely effective design, with relatively simple materials (*American Architect*), is the dormitory and apartment block for the estate of F. D. Jordan. The plan is a hollow rectangle, with a curved line on one face that is ingeniously used in the court within. There is an utter absence of pretence in this design, which is extremely straightforward, yet amply expressive of its purpose. The General Theological Seminary in New York is gradually acquiring one of the most picturesque groups of buildings in that city. The interior of the new refectory well illustrates the type of scholastic Gothic in which they

REFECTORY, HOFFMAN HALL, GENERAL THEOLOGICAL SEMINARY.

[From Architecture and Building.]

are designed, and which has been admirably employed throughout.

Among the many illustrations in the superb international edition of the *American Architect* special reference may be made to the measured drawings of Trinity Church, New York. The complete want of historical monuments, in the artistic sense, in this country renders the study of measured work almost impossible for our architectural students. Recently, however, Prof. Ware of Columbia University hit upon the happy idea of measuring up the older buildings in New York, and the present drawings of Trinity are a part of the fruits of his work in this direction. The drawings are supplemented by gelatine photographs. It is to be regretted that the very complete illustration of this historic church which this promises to furnish is not supplemented with a historical text. One week's illustrations of this paper are made up of a series of well-selected types of wrought-iron work.

Some unusually well-printed photographs have been published in *Architecture and Building*. The Syndicate Building in New York is a large commercial structure, which, at the time it was planned, was, it was publicly announced, destined to revolutionize the art of design in high buildings. Now that the building has been completed, it is apparent that nothing of the sort was accomplished. Strong vertical lines are obtained in the superstructure, but an entresol story is needlessly introduced between it and the basement, and the attic, which appears to be inevitable in New York, surmounts the cornice. Large Ionic columns are rather unhappily substituted for piers in the basement. A photograph of Phelps' Hall, Yale University, deserves notice as a successful instance of collegiate design.

THE MIDDLESEX HOSPITAL CONVALESCENT HOME.

[From the Builder.]

The *Inland Architect* publishes its usually well-chosen selection of buildings, the most important being the accepted design for the new library and museum building for the State Historical Society of Wisconsin at Madison. This is an extremely stately design, with a long colonnade extending through the second and third stories, enclosed within strong pavilions at the end. Below is a basement, and above a high balustrade. The design keeps well within traditional ideas. Quite in con-

trast is a design for the Crawford county court house in Indiana, of a Romanesque type of architecture that seems almost antiquated, so completely are our architects running to the classic.

In addition to Mr. Eyre's design, commented upon above, the *Brickbuilder* publishes an elevation of the Garden City Hotel at Garden City, Long Island, by McKim, Meade & White,—an unpretentious enough design, eminently suited in its simplicity for its location and purpose.

The most notable illustrations in *The Builder* this month are of ecclesiastical buildings. Its very valuable series of drawings of the abbeys of Great Britain is continued with Abbey Dore, and in modern work special interest attaches to some very complete illustrations of the chapel in Douglas Castle, including many details. A Wesleyan chapel at Blaina, Mon., is an interesting design, with a rather happily managed ecclesiastical effect that is sufficiently marked, and yet not of that church type of architecture generally seen in the buildings of the Established Church. Elevations and sections of Mr. Belcher's competition design for the Royal Insurance Buildings in Liverpool, commented on in these pages last month, are also published, together with an important country-house by the same architect.

Of the photographs published in *The Architect* the most important are of the New Craig House, Morningside, N. B., a very large country-house, extremely well composed, though offering considerable variety in its parts.

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Leading Articles.

*5270. Restraints Upon the Practice of Architecture. John Beverley Robinson (Showing the injurious effects of compulsory esthetic standards). Eng Mag-May. 2100 w.

*5287. Hotel Cecil (A brief description of some features of this fine hotel, being built on the Thames embankment). Plumb & Dec-April 1. 1700 w.

5324. The Art of Fireproofing. Herman B. Seely (An illustrated discussion of methods and principles, value of materials used, protective coverings, etc). Eng News-April 9. Serial. 1st part. 3600 w.

*5339. Brickwork Tests of the Royal Institute of British Architects (Abstracts of papers by Messrs. William C. Street, Max Clarke, Matt Garbutt, and Prof. Unwin, with editorial. Account of experiments, etc). Builder-April 4. 6000 w.

*5340. Austin Friars and Its Cloister. Allen S. Walker (A brief summary of the history of the Austin Friars' Church and Monastery, with an account of recent discovery which has thrown some light upon the original buildings). Builder-April 4. 2800 w.

*5341. Abbey Dore. R. W. Paul (Descriptive article with sketches of details). Builder-April 4. 4000 w.

5342. A Paper on Contracts. T. M. Clark (Read before the students of the Architectural Department of the University of Pennsylvania. The great principle which underlies the making of contracts is that they must have a consideration). Am Arch-April 11. 5800w.

*5351. The Edinburgh Royal Observatory (Some interesting details of its design and construction, as given in the *Scotsman*). Brit Arch-April 3. 1300 w.

5387. An Extensive Fire Apparatus Station, New York (Illustrated description of the enginehouse, corner of Elm and White Sts., New York. The aim has been to make it as perfect as possible in all its appointments). Eng Rec-April 11. 1800 w.

5430. Durability and Decay of Timber (Extract from Bulletin No. 10 (Timber) of the U. S. Department of Agriculture. A study of the conditions affecting the durability of wood.) Arch & Build-April 18. 1400 w.

5431. The Housing of the Poor. Ill. (The facts stated in this article are taken almost entirely from the Eighth Special Report of the U. S. Commissioner of Labor, and are quoted as directly as is consistent with the connection of ideas). Am Arch-April 18. Serial. 1st part. 2500 w.

*5441. A Further Note on the Brickwork Tests. H. H. Statham (Editorial suggestions of methods of bonding to determine strength). Builder-April 11. 1800 w.

†5487. Saint-Pierre-ès Liens; The Ancient Cathedral of Geneva. Louis Viollier and Lawrence Harvey (Read at the general meeting of the Royal Inst. of Brit. Arch. Mr. Viollier's paper is written in French, with translated abstract by Mr. Harvey, and is illustrated. Mr. Harvey's paper is a careful illustrated description of this building, with some account of the history of Geneva. Discussion of papers also). Jour Roy Inst of Brit Arch-March 19. 13500 w.

†5488. Practical Lessons Derived from the Modern Use of Terra-Cotta. J. Miller Carr (Read before the Manchester Society. The use by the present generation, and chiefly in England). Jour Roy Inst of Brit Arch-March 19. 4300 w.

*5502. The New Royal Observatory, Edinburgh (Illustrated description). Engng-April 10. Serial. 1st part. 3800 w.

5537. The Shepard Memorial Church (Brief illustrated description of the Scarborough Presbyterian church). Arch & Build-April 25. 500 w.

*5540. Notes on an Architectural Tour in England and France. W. A. Langton (Descriptive only of new work). Can Arch-April. 2100 w.

5562. Metal Stair Design. Karl Burghardt (Illustrated description of typical structural details in metal stair work, now so much in demand in the construction of fire-proof buildings). Eng News-April 16. 2800 w.

5566. The Efficiency of Modern Fireproof Building Construction (A discussion of the question of fireproofing and protective construction, reviewing recent papers on the subject, with a view to indicating wherein our best building construction fails, and how it may be improved in respect to its resistance to damage and destruction from fire). Eng News-April 16. 3000 w.

5567. The Danger of Square Cast-Iron Columns. John F. Ward (Condemning the use of square columns and giving reasons for so doing). Eng News-April 16. 700 w.

†5639. Paraboloid Sound Reflector at the

Senate House, Calcutta (Descriptive of the construction of a device for improving the acoustic properties of the Senate Hall, which was most successful and is recommended). Ind Engng–March 21. 900 w.

*5641. The Smaller Houses of the English Suburbs and Provinces. Banister Fletcher (An article illustrating and describing current practice and requirements in Great Britain). Arch Rec–April-June. 6400 w.

*5642. City Apartment Houses in Paris. Ill. Maurice Saglio (Description of French apartment houses, with short account of the tendencies of French architecture, and the principles which govern the construction of these houses). Arch Rec–April-June. 6000 w.

*5643. Japanese Architecture. C. T. Matthews (An interesting account of the history, domestic dwellings, palaces, castles, houses of the territorial nobility, ecclesiastical architecture, Buddhist temples, &c). Arch Rec–April-June. 5000 w.

*5644. Cyrus L. W. Eidlitz. Montgomery Schuyler (A very interesting illustrated description of work of this prominent architect, with brief biographical sketch). Arch Rec–April-June. 7500 w.

*5645. Characteristics of French Gothic (Editorial review calling attention to the artistic imagination and poetic conception of the French architects of the thirteenth century). Builder–April 18. 2000 w.

*5649. Architectural Rendering in Pen and Ink. Ill. D. A. Gregg (Phases of the work, with suggestions from an artist of sixteen years of practice). Brickbuilder–April. 1600 w.

*5650. Notes on Design of Brick Buildings. George F. Newton (The importance of the appreciation of opportunities and possibilities; choice of material; knowledge of theories formed from the study of successful buildings, &c). Br. Builder–April. 2300 w.

*5651. Architecture in Australia. From the *Year Book of Australia* (The year just ended is considered one in which architectural conception has been almost entirely absent. The work completed during the year is reviewed and somewhat criticised). Arch, Lond–April 17. 2200 w.

*5767. The Architect's Use of Color (Extract from papers read at the Inst. of British Architects by Halsey R. Ricardo and Christopher Whall, with editorial. The necessity of architects acquiring a more practical acquaintance with materials and their possibilities in the way of color treatment). Brit Arch–April 24. 2700 w.

*5768. Rood and Other Screens in Devonshire Churches—Past and Present. Harry Hems (The paper deals with churches that have lost their screens, stone screens missing, existing stone screens, churches in which a few remains of oak screens exist, good screens, Devon's best screens, some restored screens, and some new screens in old churches). Brit Arch–April 24. 9500 w.

5837. Preliminary Foundation Tests for the St. Paul Building (This building being erected at Broadway and Ann streets, New York, has an unusually great ratio of height to width, so that any slight settlement might be of a serious nature; hence the necessity of great care in foundations. The report of expert engineer's tests is given). Eng Rec–May 2. 700 w.

*5839. Brickwork Tests: Report on the First Series of Experiments. William C. Street and Max Clarke (Paper read at meeting of Royal Inst. of Brit. Archs., illustrated, and followed by notes, statistics and discussion. The tests were made for the purpose of ascertaining the amount of resistance possessed by brickwork under great crushing loads). Jour of Roy Inst of Brit Arch–April 2. 10000 w.

*5840. Carved Woodwork in Spanish Churches (Editorial discussion, dealing specially with the woodwork, but giving some general information of interest. There are numerous illustrations of the wonderful carving). Builder–April 25. 2200 w.

*5841. American Floors. F. Maire (An article condemning the use of carpets tacked down, and claiming that their use is due to the poor flooring laid. Presenting the subject from the healthful and cleanly standpoint). Ill Car & Builder–April 24. 1200 w.

*5842. A Typical Americal Dwelling (Illustrated description of the residence and stable of Mrs. Kathleen Martin, at Mountain Station, N. J). Ill Car & Build–April 24. 700 w.

5915. The St. Paul Building, New York City (Illustrated description). Eng News–May 7. 3000 w.

†5916. The First Prize Design for New Premises, Bank of Madras, Submitted by "Hope." S. S. Jacob (Illustrated description, with plans, specifications and abstract of estimated cost). Ind Engng–April 4. 2000 w.

5921. Stable Construction for a Country Estate (Plans and details of the stable and coach-house built for W. F. Havemeyer on his estate at Seabright, N. J. Illustrations of ground plan, elevation and section). Eng Rec–May 9. 1000 w.

5923. Notes Upon the Architecture of China. F. M. Gratton (Abridged from a paper read before the Roy. Inst. of British Architects. Historical account of cities, walls, temples, &c., in this first part). Arch & Build–May 9. Serial. 1st part. 3800 w.

5924. History of the United States Capitol. Glenn Brown (Account begins with the selection of the site and carefully reviews all points of interest connected with the preparation for building, the plans submitted, and final selection in this first number). Am Arch–May 9. Serial. 1st part. 3000 w.

†5927. The Scientific Construction of Chimneys. H. J. Palmer (From *The Builders' Journal.* A consideration of the laws and principles of good draught, and other points of importance in chimney construction). Ind & East Eng–April 11. 1700 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Mississippi Improvement by Contract.

MR. COPPÉE'S article on "Bank Revetment on the Mississippi" will give the readers of THE ENGINEERING MAGAZINE an additional interest in the proposal to take a part at least of the improvement work out of government hands, and place it with private contractors.

The passage of house bill No. 2,779 would give to Isaac M. Mason, W. M. Samuel, and their associates the contract for improving the channel from St. Louis to Vicksburg for the sum of one million dollars per annum for a period of twenty years.

This proposition, says *Engineering News*, has called out "some very pertinent remarks upon the same subject by Mr. Henry Flad, past-president of the American Society of Civil Engineers and a member of the Mississippi river commission. Mr. Flad says, first, that the efficiency of movable dykes is still problematical, as none have been tried on the Mississippi river. They might be successfully used in closing channels and in directing currents; but on long bars they would simply cause the removal of sand from one place to deposit it at another lower down. Some other devices mentioned in the bill are also equally doubtful in practicability, and some have been tried and found to fail in all save exceptional cases.

"On the other hand, dredges have been fully and successfully tried in this work. They take up the sand and actually remove it to points remote from the channel, and where it can not be returned by the current of the river. Dredges have the advantage over jetties and movable dikes of being able to begin work before the river has reached its lowest stage; as the dredge 'Alpha,' belonging to the commission, can work at 12 feet below the surface, the dredge 'Beta,' at 20 feet below, and the new dredges to be built can operate at 15 feet. The capacity of these dredges already in hand is 600 cubic yards per hour for the 'Alpha' and over 5,000 cubic yards per hour for the 'Beta.' Mr. Flad believes that these two dredges would be sufficient to keep the river free from obstruction by bars from Cairo to Memphis, and provide a channel 250 feet wide and 9 feet deep throughout.

"Messrs. Mason & Samuel propose a channel only 6 to 7 feet deep and 100 feet wide above Cairo, and 150 feet wide below Cairo. This width, Mr. Flad declares, is entirely insufficient for the safe passage of boats. For the above work Messrs. Mason & Samuel would receive, under the bill, $600,000 per annum for creating and maintaining a channel 7 feet deep and 150 feet wide up to Cairo, and $400,000 per annum for a channel 100 feet wide and 6 feet deep from Cairo to St. Louis. For each additional foot of depth secured they would receive $50,000 per year above Cairo, and $100,000 per year below Cairo. Mr. Flad points out that in 1882 and 1885 the lowest water in the river was never below 8 feet, and in 1890 it was never lower than 10 feet. This may occur in the next twenty years; and under similar conditions the contractors would receive a bonus of $200,000 for the two years of 8 feet depth, and $300,000 for the one year of 10 feet; adding the stipulated annual sums, the contractors would receive $1,800,000 plus $500,000, or $2,300,000, in these three years, without incurring any outlay whatever except for the maintenance of plant and for watchmen.

"Mr. Flad then contrasts this exhibit with the work to be done by the Mississippi river commission under its present organization. He finds fifty crossings between St. Louis and Cairo, and fifty-three between Cairo and Vicksburg, on any of which bars may appear and obstruct navigation. He then has a profile made, on the basis of the low-water season of 1895, and figures the total probable quantities of excavation as follows: above Cairo, channel 100 feet by 6 feet, 55,220 cubic yards;

for a channel 250×9 feet, 1,471,420 cubic yards. Between Cairo and Vicksburg, for a channel 150×7 feet, 222,786 cubic yards; for a channel 250×9 feet, 1,682,520 cubic yards.

"He estimates that, with an average capacity of 800 cubic yards per hour, 7 dredges and dredging plants would be needed between St. Louis and Cairo, and 9 dredges and plants from Cairo to Vicksburg. If channels of the depth and width proposed by Messrs. Mason & Samuel are to be secured, sets of 3 and 4 dredges of the same capacity would do the work. Mr. Flad estimates the cost of one dredging-plant of 800 cubic yards' capacity as follows:

One dredge	$100,000
One pile-sinker	5,000
One tender	25,000
One surveying-launch	1,000
One fuel-flat	1,000
Total for one plant	$132,000

"The cost of operating one such dredge and plant, as fixed by one year's experience with the 'Alpha,' is $5,500 per month. For one year's work about Cairo, on the plan proposed by the commission, the cost would be $214,500; to this is added 10 per cent. of the first cost of the plant for renewals and repairs, making $306,900 for the total cost of operation for all dredges for one year, or $6,138,000 for twenty years. From Cairo to Vicksburg, on a similar basis, the cost of operation would be $349,800 per year, or $6,996,000 for twenty years.

Applying the same assumptions to the plan of Messrs. Mason & Samuel, the operating expense of their dredges above Cairo for one year would be $127,600, with the ten per cent. added, or $2,552,000 in twenty years. From Cairo to Vicksburg the annual cost would be $157,300, or $3,146,000 for twenty years. Mr. Flad summarizes these two exhibits as follows:

Channel 250×9 ft. above and below Cairo.

First cost:

St. Louis to Cairo, 7 dredges and plants at $132,000	$ 924,000
Cairo to Vicksburg, 9 dredges and plants at $132,000	1,188,000
Operating expenses for twenty years, as above: St. Louis to Cairo	6,138,000
Cairo to Vicksburg	6,996,000
Total	$15 246,000

Channel 100×6 ft. above Cairo, and 150×7 below Cairo.

First cost:

St. Louis to Cairo, 3 dredges and plants at $132,000	$ 396,000
Cairo to Vicksburg, 4 dredges and plants at $132,000	528,000
Operating expenses, for twenty years, as above: St. Louis to Cairo	2,552,000
Cairo to Vicksburg	3,146,000
Total	$6,622,000

"If Messrs. Mason & Samuel would carry out their contract for twenty years, they would receive $20,000,000 for work costing at most $6,622,000."

If, however, as is very likely, navigation interests should demand a larger channel, and the contractors should "conclude to adopt and maintain the channels proposed by the commission, they would receive the $20,000,000 plus a bonus of $7,000,000 for the 3 feet additional depth above Cairo and the 2 feet additional below (at $50,000 and $100,000 per annum per foot). This would make the cost $11,754,000 more than the same work could be done for by the commission; the relation being as $27,000,000 is to $15,246,000, or an excess of nearly fifty per cent. in cost.

"Since the above estimates were prepared, Messrs. Mason & Samuel have increased their proposed channel width to 200 feet above and 250 feet below Cairo. This would increase their expenditure in twenty years about $10,000,000, and reduce their profit to about the same sum. As it would be difficult to determine whether or not the terms of any contract were fulfilled, the employment by the government of a considerable number of surveying parties and inspectors would be necessary. This would involve extra expense, which should properly be considered, with any contract plan."

This last consideration, though minor, is not unimportant; altogether the expediency of the change seems dubious.

Seepage Waters from Irrigation.

THIS branch of irrigation hydraulics has been the subject of some most thorough and valuable work by Prof. Carpenter and his associates, of the State Agricultural College, at Fort Collins, Colo. The results are exhibited in Bulletin No. 33 of the agricultural experiment station, and are abstracted by the *Engineering Record;* they are obtained from a study of the valleys of the Cache à la Poudre and the South Platte rivers.

"The lands artificially supplied with waters in these districts are not sensibly different from much of the irrigable lands of the southwest in being of a sandy, or, to some extent, gravelly, nature beneath the surface. Irrigation has been practised in the fields of observation from two or three to thirty-five years, and the areas under consideration are about 130,000 acres in the Poudre Valley and 75,000 to 80,000 acres in that of the South Platte.

"One of the most important of the questions that have arisen in connection with the subject of irrigation is that of the return seepage or flow of the water from the distributing canals to the streams from which it is taken, for it has direct bearings, not only upon the irrigating capacity of the stream, but also on some essential legal questions connected with the rights of the up-stream water-takers. There is nothing new in the character of the questions involved, for they long have attracted attention among engineers in the irrigation field; but we believe that few or no other efforts have been made toward solving the problems involved so systematic and thorough as those put forth in Colorado. Both the Cache à la Poudre and the South Platte have distributing canals leading from them at different points in their courses, and thus lend themselves admirably to the gaging observations, which extend over a distance of two hundred miles and more, requisite for the work undertaken. When it is remembered that the quantity of water required for the purposes of growth of one pound of dry vegetable product may be estimated roughly at three hundred to three hundred and fifty pounds, it readily may be appreciated that large excesses of water over the actual needs of vegetation are supplied in the ordinary processes of irrigation, and it becomes a matter of great practical importance to determine where it goes to.

"The gagings were carefully made with current meters and floats at the points where the irrigating canals joined the river, both in the river and in the canals, thus establishing the volumes of flow in both. Similar observations were also made at various points in the canals. A comparison of these results showed how much volume was gained or lost between any two consecutive points of observation either in the river or in the canals, and thus enabled the amount of return flow or seepage to the river to be determined. This quantity per mile of river course naturally varies widely with the topography of the country adjacent to the river and with the quality of its material, as well as with the adjacent irrigated area, and with the temperature of the sub-surface material through which the water must flow. The gain in volume for the Cache à la Poudre river was found to rise as high in one instance as 17.09 cubic feet per second per mile of progress down stream, with, of course, some losses. For the South Platte the average gain in volume per mile of progress down stream ranged from 1.6 to 3.4 cubic feet for different months per year. Or, to put it in another way, 'the seepage from 1,000 acres of irrigated land on the Poudre river gives 1 cubic foot per second constant flow; on the upper Platte, 1 cubic foot to about 420 acres; on the lower Platte, 1 cubic foot to 250 acres.' Or again, about one-third of the water applied in irrigation on the Poudre returned to the river, and about 30 per cent. on the Platte.

"Two important results follow these determinations. In the first place, as the motion of the water is excessively slow through the sand, the seepage volume acts as a reservoir from which a practically uniform discharge into the river takes place throughout the year as a supplement to the rainfall, which has an average annual value of not more than fourteen

inches in this part of Colorado; and, in the second place, the down-stream takers have available about one-third of the water taken from the river by the up-stream users. It is observed also that, as might be anticipated, the seepage continues to increase for a long period of time with the filling of an increased proportion of the sand voids. Thus the irrigation of the upper districts of the river largely augments and continues to augment for a considerable time the irrigating capacity of the river in the lower reaches of its course. These are among the more important of the results established by the observations under consideration, and that they are of practical value is evident from the fact that 'the capital value of the seepage water received in the valley of the Cache à la Poudre is not less than $300,000, and perhaps $500,000, and for the Platte it is from $2,000,000 to $3,000,000.'"

Readers of Mr. Hinckley's excellent article on "Pump Irrigation on the Great Plains," in the April number of THE ENGINEERING MAGAZINE, will find an especial interest in this report, for it suggests that the section benefited by irrigation may be much wider than the measure of the immediate surface to which the water is directly applied.

Approximate River Gaging.

IN the report of the California commissioner of public works, Mr. C. E. Grunsky has suggested a method to be used where great accuracy, special apparatus, and trained assistants are not required. The substance of this report is abstracted by the *Engineering Record* (March 7), from which we take the following description:

"In the light of the experience on the Sacramento, San Joaquin, and Feather rivers, the following method is suggested, and can be recommended for all ordinary open earthen channels not too diminutive. By means of surface floats of any pattern, not exposed too greatly to wind action, determine the surface velocity from bank to bank. By sounding, determine the cross-section of the stream at the upper end of the course over which the floats are run; also the cross-section at the lower end of the course, and the cross-section midway between these two. From these three sections determine an average section by giving double weight to the middle section, and plat the same, showing the position of the water surface at the time of the gaging. Plat above the water surface line, on any convenient scale, the surface velocities, and construct the curve of the surface velocity. Reduce all velocities indicated by this curve by multiplying by the ratio found in the following table:

Width, divided by average depth =	5	10	15	20	30	40	50	75	100
Ratio of mean velocity in any vertical to the observed surface velocity $\frac{V}{V_s}$ =	1.03	.99	.96	.94	.91	.89	.87	.84	.82

and treat the resulting curve as a curve of the mean velocity in vertical longitudinal planes. At as many selected points as seems desirable, multiply depth of water by corresponding mean velocity, scaled from the curve, and plat the product as a point on a discharge curve. When sufficient points of the discharge curve have thus been found, complete it. The area inclosed by it and the horizontal line from which discharge is platted will represent the total discharge.

"[It is not correct to divide the area of the curve of mean velocities by the width of the water surface, and to call this the mean velocity of the stream. This would only then be correct when the cross-section of the stream is a rectangle. This mistake is made by many hydraulicians. See *Handbuch der Ingenieurwissenschaften*, Part III., p. 251, for error of this character.]"

The New Railroad Bridge at Niagara.

THE railroad suspension bridge at Niagara Falls is to come down, and give place to a steel-arch structure, which is described in the *Railroad Gazette* of April 24 with specifications and drawings. The *Gazette* says:

"This has been under discussion for a good while, and Mr. L. L. Buck, chief engineer for the bridge companies, prepared plans and estimates of cost some months

ago. Recently an agreement was entered into between the Niagara Falls International Bridge Company and the Niagara Falls Suspension Bridge Company on one side, the owners of the bridge, and the Grand Trunk Railway Company on the other side, as the actual users of the bridge, under which work can be begun at once in building the new structure. Plans and specifications have been sent out for bids, and it is believed that work will be begun this summer.

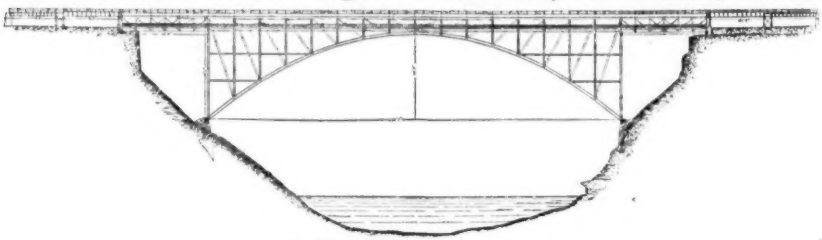
"The existing suspension bridge was completed in 1855. It was built from the designs of Mr. John A. Roebling, and under his supervision as chief engineer. It was a very remarkable engineering work in its day, and has stood as a monument to the genius of its designer. In 1880 the suspended structure, and in 1886 the towers, were renewed, from the designs of Mr. L. L. Buck and under his supervision. This work was done without interrupting traffic, and is considered to have been one of the most daring and original things ever attempted by an American engineer. Soon the record of this important work of Mr. Roebling and Mr. Buck will exist only on paper.

"Bids are called for the construction and erection of the metallic superstructure, and for the removal of the present suspension bridge and towers. The masonry foundations and the temporary anchor pits will be prepared by the bridge company.

"The bridge will have a main span 550 feet long between centers of end pins, and will be connected with the top of the bluff on each side of the river by a trussed span 115 feet long. The main span will be an arch with horizontal upper chords, hinged at the skewbacks, and each truss will have a batter of one horizontal to ten vertical. The width between the axes of the top chord will be 30 feet; between the axes of the rib at the crown it will be 34 feet; and between centers of skewbacks it will be 56 feet 7¾ inches. The axes of the upper chords will be 134 feet above the skewback centers, and the axes of the ribs at the crown will be 114 feet above the skewbacks. One end of each shore span will be hinged to the arch by a pin at the intersection of the end post and top chord of the arch, and the shore end will rest on expansion rollers on masonry abutments. The bed plates of the arch will rest on masonry founded on the rock.

"The bridge has two floors, the upper one carrying the railroad tracks and the lower one the highway, sidewalks, and trolley track."

"The end spans and the first panels and post of each end of the arch will be erected on scaffolding. The end spans will be connected with the end post of the arch and, by means of the approach girders, with the temporary anchorage, and then the two parts of the arch will be built out by cantilevers. As the present bridge will continue in use during construction, the upper floor beams of the arch must be left out, until the old suspended superstructure can be raised high enough to permit the new beams to be inserted under the upper chords of the old structure. During this time the old structure will rest on the lower floor beams of the arch bridge, and consequently the cables of the old bridge can be taken apart or removed, and the towers can be taken down. The suspended structure must then be pushed far enough to one side to permit a track to be laid on one pair of the new stringers, after which



NEW RAILROAD BRIDGE AT NIAGARA.

the old superstructure can be taken apart and removed, and then the other track laid and the bridge completed. As the new bridge will have the weight of the old suspended structure and its trains to support, before the upper beams can be inserted, it is probable that the upper chords will need to be temporarily braced against the old structure, until the beams and stringers are in place. During erection it will be difficult to use a traveler, as the old bridge is in the way. It seems best to use a couple of heavy wire ropes over the towers, with trolleys to carry out the material. Cages for the men can be suspended from the old bridge wherever required.

"The bridge is designed to carry on each railroad track a load of two locomotives, with four pairs of drivers each and 40,000 pounds on each pair, followed by a train of 3,500 pounds per foot,—that is, 7,000 pounds' live load on that floor. It is designed to carry, in addition, a live load of 3,000 pounds per running foot on the lower floor, making 10,000 pounds, live load in all. It will be seen that the whole forms an unusually heavy load."

The Costliness of Cheap Engineering.

UNDER this title, *Engineering News* publishes a communication making some excellent points against the unwise and injurious methods which have been too often adopted in the management of public works of an engineering character.

Perhaps the strongest point made is the exposition of "the wrong which cities do to their own interests and to contractors by altering the plans and specifications of competent engineers to suit the funds which they have available for the work." The writer had just come from "looking at a large sewerage system which is worse than worthless. It was planned by a good engineer, but the plans were changed by one who was unworthy to unlatch his shoestrings, and the taxpayers have to suffer." His conclusion regarding the matter is thus summed up: "Our cities do need thoroughly competent and conscientious engineers as advisers—men who cannot be bought and sold. There are plenty of such men to be had. If our cities will rely on such engineers to prepare plans for their work, and allow no changes except such as these engineers may make, we should then have good public work and tricksters would not bid on it."

A Correction.

MR. E. SHERMAN GOULD'S simplified hydraulic formulæ, which appeared in this department recently, copied from the *Engineering News*, were incorrectly printed in the original publication, and a later issue of the *News* makes the correction, which is the substitution of the multiplication sign for the plus signs in the second members of the equations throughout.

The end of the quotation beginning on page 1,115 is left indefinite by typographical error in omitting the concluding marks. These should be inserted at the end of the eighth line on page 1,116. The remainder of the paragraph is not direct quotation, and the comment as to the insufficiency of the fifteen per cent. margin is the reviewer's, not Mr. Gould's.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

5325. The Austrian Tests of Arches. Mansfield Merriman (A brief synopsis of each of the seven chapters of the report presented by the committee appointed by the Austrian Society of Engineers and Architects to undertake a series of experiments on arches. The article is well illustrated, showing the manner of testing with explanations and results). Eng News-April 9. 2200 w.

5516. The New Railroad Bridge at Niagara (Short description of steel arch to replace the old suspension railroad bridge. Contains brief general specification of material, erection and loading). R R Gaz-April 24. 2000 w.

*5555. The New Waterloo Bridge Over the River Ness at Inverness (The piers are of cast iron cylinders and the spans steel lattice girder. It replaces the "old black bridge" built 90 years ago. The construction is fully described,

We supply copies of these articles. See introductory.

and illustrated by a view of the structure). Eng, Lond–April 10. 2400 w.

5565. Trestle for Single-Track Electric Railway (Description with specifications. The bents and framing on a 350-ft. radius curve are illustrated fully). Eng News–April 16. 600 w.

5620. Cantilever Bridges (A brief abstract of Prof. Edgar Marburg's paper before the Engineers' Club of Philadelphia, the general conclusion being rather adverse to the economy of the cantilever type, except for long spans and situations where falsework is extraordinarily expensive). Ry Rev–April 25. 900 w.

5680. The New Bridge Over the Hudson River at New York (Illustrated description of the proposed New York and New Jersey Railroad bridge across the Hudson River). Sci Am–May 2. 1300 w.

5749. A Proposed Device for Weighing Stresses Caused by Moving Trains (The device described for the determination of the unknown quantities in bridge stresses consists of a series of hydraulic track supports, recording pressures automatically in connection with multiple instantaneous photographs showing the wheel positions of the passing train). Eng News–April 30. 600 w.

5750. La Rue's Formula for Curvature of Chords in Bridge Trusses (Letters from R. C. Berkeley, Jr., and Henry Szlapka, with reply from Benj. F. La Rue. Criticism and modification of Mr. La Rue's statements regarding tension in a vertical post under full load). Eng News–April 30. 900 w.

5754. Four-Track Swing Bridge over Harlem River, New York Central & Hudson River R. R. (Illustrated description of the general features only of the operating machinery. Drawings giving dimensions, material and details of construction). Eng News–April 30. 1000 w.

5909. The New Tennessee River Bridge at Knoxville, Tenn. (An illustration of the aesthetic element determining the choice of a bridge. The structure is of steel, arched cantilever design, for roadway and sidewalks). Eng News–May 7. 400 w.

Canals, Rivers and Harbors.

*5393. The Harbor Works at Tampico (From a paper read at a meeting of the Institution of Civil Engineers. This Mexican port, on the gulf coast, is interesting. Since the harbor improvements the trade has doubled in value, making it probably the second port in Mexico. Interesting also on account of the peculiar engineering difficulties). Trans–April 3. 1000 w.

*5552. Harbor Development in New Zealand (The Port of Wellington is the business center of the colony. A map is given of the berthage accommodations and the town, with description). Trans–April 10. 3000 w.

5564. The Proposal to Improve Mississippi River Navigation by Contract (Showing that the proposed private contract method would double the cost for the same amount of work done). Eng News. April 16. 900 w.

5628. Hydraulic Suction Dredge for the Navigation Improvements of the Mississippi River (An excellent description, with illustrations, of the same dredge reviewed in our Feb'y number). Eng News–April 23. 3000 w.

*5672. The Heinsrichsburg Canal Lift (Illustrated description of an interesting mechanism, designed to overcome a difference in elevation of 52½ ft. in the canal joining the Port of Emden with the Westphalian Coalfield. It is expected that it will be much more economical in working than those depending upon hydraulic presses for balancing power). Eng, Lond–April 17. 1300 w.

5747. Mr. Menocal's Reply to the Nicaragua Canal Commissioner's Report (In this reply, Civ. Eng. A. G. Menocal takes the ground that while the company regards and has treated the project as a business enterprise, with a view to commercial requirements, technical success, and financial results, the Bd. of U. S. Engineers ignores two of these conditions and considers the project from the point of unlimited expenditure, without any question as to financial results, and provides beyond commercial requirements for the present, for the accommodation of demands that, at the utmost, can only be claimed to be occasional. Both the board and the company are agreed as to the entire feasibility of the project. This reply has been submitted to the House Committee on Commerce. The editorial on this reply expresses the view that further surveys are advisable, and otherwise criticises Mr. Menocal's remarks). Eng News–April 30. 10500 w.

5751. The Evolution of Dredging Machinery. H. St. L. Coppée (A communication aiming to throw light on the subject of the cause of difference between the dredging machinery used in this country and in England). Eng News–April 30. 1500 w.

Hydraulics.

5386. Costs of Pipe Laying. G. S. W. (Abstracted from *The Technic*. Notes on nine cases from actual practice, giving conditions, dimensions, wages and other necessary data, with the cost of each item. In most cases old pipes had to be removed and expensive connections made). Eng Rec–April 11. 900 w.

5622. Efficiency of Nozzles for Small Water Motors. Arthur B. Ilsley and Herbert R. Thurston (Graduating thesis awarded first honorable mention in Engineering News Thesis Competition for 1895. The tabular statements of the experiments are briefly summarized in the table given, and the cuts represent a selection of the different forms of nozzles tested). Eng News–April 23. 1800 w.

5663. Hydraulic Rams. J. Richards (A study of the efficiency and defects of rams, giving experiments and illustrations). Eng & Min Jour–April 25. 2400 w.

Irrigation.

†5632. Irrigation in the North-West (From the report of the Irrigation Branch of the North-West Provinces, on the Great Ganges Canal, the Eastern Jumna Canal, the Agra Canal, the Bet-

wah Canal, with reports of progress). Ind & East Eng–March 28. 1600 w.

†5742. Irrigation in Siam (Account of the progress made by the Siamese in the art of irrigation, from which it appears that artificial irrigation is well advanced in Siam and its advantages fully appreciated. A description of some important irrigation works now in progress follows). Consular Repts–May. 1000 w.

Miscellany.

†5261. Slag Cement in Germany (Reports in answer to instructions from the Department of State, from the various consuls, with supplementary report describing the method of manufacturing slag cement). Consular Reports–Feb. 4000 w.

5329. Specifications for the State Highways of Massachusetts (Adopted by the Mass. Highway commission and includes specifications on earth work, rock excavation, rubble masonry, broken stone, telford gravel foundation, vitrified clay pipe, drains, finishing, gutters, etc). Eng News–April 9. 2200 w.

*5349. Famous Tunnels (A few particulars respecting some of the more famous tunnels in the world). Ill Car & Build–April 3. 1400 w.

*5397. Scientific Timber Testing. B. E. Fernow (By the chief of the Division of Forestry, in the United States Dept. of Agriculture. The paper deals with the considerations which are necessary for successful testing). Digest of Phys Tests–April. 3300 w.

*5398. Systematic Inspection of Material. L. S. Randolph (A general paper showing the tendency and importance of tests of material, such as is bought by the purchasing departments of railroads, and claiming that thus only can we avoid buying adulterated or imperfect material). Digest of Phys Tests–April. 1300 w.

*5401. Strength of Ice. C. W. Beech, A. M. Munn, and H. E. Reeves (Extracts from *The Technograph*, No. 9. The device used to prevent unequal pressure on the faces of the ice cubes while crushing, is illustrated and the data is given in full for 55 specimens of ice tested, averaging 1451 lbs. per sq. in. compressive strength, and 19 slabs, averaging 718 lbs. per sq. in. The average tensile strength per sq. in. on 34 specimens was 165 lbs). Digest of Phys Tests–April. 2000 w.

*5442. Notes on Cement Testing. H. M. Morris (The first paper deals briefly with sampling, fineness, sand, mixing, moulding, setting, checking, boiling and tension tests). Ill Car & Build–April 10. 1800 w.

5528. A Hypothetical New Hydraulic Cement. A. D. Elbers (A scientific discussion of the essential properties in hydraulic cements and the effects upon the cement of hydration). Eng & Min Jour–April 18. 2200 w.

5563. The Manufacture and Use of Sand-Cement (Discussion of the qualities and tests of this new cement with illustrated description of works just put up at Long Is. City. One part of sand is ground with one part of cement in a cylindrical flint ball pulverizer making a cement which possesses great strength). Eng News–April 16. 1800 w.

5568. The Pennsylvania Avenue Subway and Tunnel in Philadelphia, Pa. (The engineering work involved in removing grade crossings is well illustrated and described. A bird's eye view with sections of overhead street crossings, tunnels, drains, profiles, etc., explain the construction fully). Eng News–April 16. 1600 w.

5623. The Claims of the Contractors for the New Croton Aqueduct (An interesting dispute between the contractors and the city, brought about by a change in design after the bids were made). Eng News–April 23. 1700 w.

*5636. Experiences in an Engineer's Practice. Walter V. Rice (Providing against settling in insecure foundations at the Petrie St. bridge, Cleveland, O). Jour Assn of Eng Soc–March. 2000 w.

5752. Effect of Magnesia on the Strength of Cements When Subjected to Freezing. Frank Haas and John Alexander McGraw (Thesis receiving second honorable mention in Eng. News Thesis Competition for 1895. Experiments made to find a means for counteracting the loss of strength from effects of low temperature). Eng News–April 30. 1000 w.

5755. Formulas for Long Columns (Letters from J. B. Johnson, and A. J. DuBois closing the discussion of the subject, and making an analysis of the points in dispute and of their positions concerning them). Eng News–April 30. 3800 w.

*5792. The Gohna Landslip and Flood (Means adopted by the government to prevent loss of life and property within range of the enormous volume of water that was expected to escape from the bursting of the dam formed in the river Birahi Gunga, one of the tributaries of the Ganges, by reason of a great landslip that blocked the stream in 1893. This is claimed to be the first authoritative account yet published). Eng, Lond–April 24. 4400 w.

*5799. Formulæ for Calculating the Perforation of Armor (Formula suggested by Captain Tresidder, of Brown's Armor Plate and Steel Works, which might, he urged, be adopted with advantage internationally on the following grounds: (1) Close agreement with actual results obtained at various velocities; (2) theoretical soundness; (3) simplicity. It is claimed that this formula gives results for high velocities which are much more nearly correct than the recognized British formulæ of Maitland or Fairbairn). Eng, Lond–April 24. 1800 w.

5913. Steel Rails for Common Roads (An editorial examination of this proposed innovation with a view to gain a clear idea of its possible merits and demerits. The conclusion is that the merits as contrasted with the demerits, do not warrant an actual trial in service. The subject is very ably treated). Eng News–May 7. 3200 w.

5932. A Topographic Map of Butte, Montana. R. H. Chapman (Showing the great economy of the plane-table and stadia method with reference to time, accuracy and actual cost where the scale is sufficiently large to warrant it). Eng & Min Jour–May 9. 650 w.

DOMESTIC ENGINEERING

Coal and Gas for House Fires.

DR. J. B. COHEN and Mr. J. H. Russell have jointly been making an experimental investigation upon the combustion of coal and gas for house fires, and have presented the results in a well-written paper read before the Yorkshire (Eng.) Society of Chemical Industry. In this paper, printed in *Journal of Gas Lighting* (March 24), the authors explain that the objects of their experiments were to again determine the extent to which town air is polluted by the combustion of coal, and to ascertain whether a more extensive use of gas fires might be recommended by way of mitigating or removing the evil. The repetition of the experiments which the authors had previously performed was required by the discovery of sources of error in the methods then employed.

These sources of inaccuracy were, first, the hygroscopic property of the cotton-wool plugs by which the soot was collected, which, not being at first sufficiently appreciated, led to an excessive estimate of the soot, determined by weighing the chimney plugs before and after collecting the soot upon them. By thoroughly drying the plugs before weighing them, a more accurate determination of the quantity of soot collected has now been made.

A second source of error arose from periodic, instead of continuous, collections of the gases of combustion. By a system of continuous collection, a more accurate average of the amount of carbon dioxid carried out of the chimney has been obtained, and the results are presented in tabulated form for gas fuel and for coal.

"Using a similar kind of coal to that employed in the former determinations, the weight of soot per 100 litres of chimney gases and the percentage of carbon dioxid were both found to be much lower than on the previous occasions. The net result was to raise the percentage of soot on the carbon burnt from 5 to an average of 7.7 with this particular quality of coal. The average quantity of soot in twelve analyses, including eight of Yorkshire coals, two of Durham coals, and two of Wigan coals, amounted to 6½ per cent. on the carbon burnt. The quantity of soot obtained in different experiments with the same kind of coal varied, being no doubt influenced by the manner of firing and by the amount of draught. There was no slack in any of the samples."

The authors remark that "the use of gas in place of coal has often been suggested as a remedy for the smoke nuisance; and they allude to the fact that many people profess an objection to gas fires, either from experiencing a real feeling of discomfort, or from purely sentimental reasons. It has been alleged, moreover, that carbonic oxid is given off into the room from gas fires,—a statement which, if true, would manifestly condemn their use. They point out that it is impossible to ascertain or explain the cause of, and therefore to controvert, sentimental objections; but the other matters may be easily tested,—*i. e.*, as to the evolution of carbonic oxid, and as to the cause of physical discomfort. The authors had three different kinds of gas stoves placed at their disposal; and they were able to make a rough comparison between them and coal fires, as regards heating effect, from the point of view of economy and health."

The draught of a chimney is judged to play an important part in the heating of rooms by gas, and also with respect to the ventilation. It is further believed that gas can nowhere be used for heating at less than double the cost of coal; and in Leeds, where the experiments were performed, gas would cost three times as much as coal for the same heating effect.

"The authors think there is no doubt that a higher heating effect with coal may be attained in modern modifications of the coal-fire on the 'reflex' or 'lean-to' back principle, with small flue aperture; but they had no opportunity of testing this. In the

case of a coal-fire the heating is mainly done by radiation; and the air of the room is only slowly warmed by contact with walls, ceiling, etc. With gas stoves, on the other hand, the air gets rapidly warmed. It is, therefore, necessary to guard against over-heating of the air by ascertaining the temperature from time to time and adjusting the gas; for air warmed above a certain temperature is apt to cause a feeling of dryness and discomfort. If the fireplace behind the gas-fire is closed so as to get the maximum heating effect, some opening into the chimney should be contrived by making an aperture at the ceiling-level. If the above conditions are observed, a gas-fire is a perfectly healthy heating appliance, more effective and more cleanly, although at the same time more costly, than coal. It must be remembered that these experiments on the comparative heating effects of gas and coal fires, although carried out with as much care as the circumstances allowed, do not pretend to absolute accuracy."

The amount of air drawn through the room for combustion of the gas (stated by the authors to be six times the volume of the gas burnt) seems too small; the amount is probably more nearly ten times the volume of the gas, and Mr. T. Fairly, chairman of the meeting at which the paper was read, stated that he had found this to be the amount.

Dangerous Enemies of Street Shade-Trees.

THE beauty of streets, as well as the comfort of urban dwellers, is admittedly enhanced by trees planted in the streets in the usual manner along the curbstones. The grateful shade in summer, and the partial obscuration of the long monotony of blocks of buildings fronting directly upon streets, are effects that would be much missed in many towns. Unfortunately, however, through the selection of trees ill adapted to this use, faults in planting, lack of proper care, and the attacks of natural enemies, the trees in a large number of American cities and villages are in a lamentable condition. *Garden and Forest* (April 8) has a good and timely editorial, discussing this subject very thoroughly.

Trees named as ill adapted to street planting are the short-lived sycamore maple, the weakly-constituted European ash, the brittle-limbed ash-leaved maple, and the poplars of all varieties "whose trunks are soon riddled by borers." The faults indicated as special in the trees thus named are generally to be avoided. Of trees not subject to these disabilities may be named live oaks and elms; but climatic conditions must influence selection, and probably there is no tree on the face of the earth that has not insect enemies. The soil, too, must be specially prepared, and must influence selection and treatment after planting, in order to obtain good results.

"There is no more excuse for planting a tree in imperfectly-prepared soil than there would be for sowing wheat on an unplowed field. If the young tree has abundant food for its roots and room for its branches to spread, and is properly anchored until it gets firmly set, it probably is left unmulched, and therefore exposed to drought and changes of temperature, or it has no guard against the teeth of horses, no opening in the asphalt about its base to receive water, or it is mangled by some ignorant tree-trimmer, and its wounds left bare to invite the rot fungus. The hopeless part of the case is that its natural protectors, the people about it, have no affectionate interest in it. They see it languish without any attempt to revive it. They do not consider one who wounds and bruises it a public malefactor.

"No doubt, the way to insure satisfactory street-trees is to put the whole business in the hands of a skilled commission. There is no reason why a man should be allowed to select the tree to plant along the street before his house, or to plant it in his own crude way, any more than he should be permitted to build his own sewer or his own sidewalk to suit his personal whims. Where there is a commission of men who understand their work, like those in Washington, every tree is inspected before it is planted, so that specimens of even growth and similar shape

are secured. They are then scientifically planted and cared for; and, more than that, they are systematically pruned,—an operation which street-trees need above all others. Until the planting and care of these trees is considered an important municipal matter, like providing a water-supply, and one which as truly demands expert ability, the trees in our streets will be likely to excite commiseration rather than pride."

Public sentiment must be enlisted to secure reform in this matter. "One of the most serious dangers" now threatening urban trees is alleged to be the increased use of electricity. "No tree which stands on the public highway is out of danger from the axes of linemen." This statement is followed by a list of instances where noble trees have been thus ruthlessly sacrificed, and, although in some cases exemplary damages have been recovered, these cases are few, and have not served to check this sort of vandalism.

The natural enemies of trees are also increasing. Among these the gypsy moth, the elm-leaf beetle, and other insect foes have been successfully routed by spraying; but spraying, to be effective, requires to be thoroughly and rapidly done, in order to get over all the trees at the time when it is useful. Hand-pumps are too slow, and a steam-driven spraying apparatus is suggested as a much-needed appliance. "Tree protector" leagues should be organized. As an example of such an organized effort the following is quoted.

"Last summer one of the Washington newspapers, in every issue through the summer, contained a coupon reciting briefly the desirability of protecting the shade trees and enrolling every signer as a member of such a league, pledging him to do his best toward destroying the injurious insects upon the city's shade-trees adjoining his residence. If every household could be made to take a proper interest in this matter, the work would be half done. What is needed is intelligent work at the proper time,—the burning of the webs of the fall web-worm in May and June, the destruction of the larvæ of the elm-leaf beetle about the bases of the elm-trees in late June and July, the picking of the eggs of the tussock-moth in winter, and equally simple operations for other insects when they become especially injurious."

Ventilation of Gas-Heated Rooms.

THIS subject was treated in a paper read by Mr. Donald McDonald before the last meeting of the Ohio Gas-light Association, reported in the *American Gas-light Journal* (April 13). The author considered it not possible to devise a better means of ventilating a heated room than that "survival of the fittest," the open fireplace; but this method had to be modified when furnace heating came in, and again modified for steam heating and for hot water heating; and, now that gas heating has come in, it requires still further modification.

"Not only must we deal with the vitiation of the air by the inhabitants of the apartment, but we must also take into consideration the fact that the gas heater itself, in most cases, is putting out into the apartment large volumes of carbonic acid, water, and nitrogen,—sometimes less harmless gases,—and that it is continually taking from the air of the room the life-giving oxygen, leaving the air to this extent dead and uninvigorating. The products of combustion of any fire are neither more nor less than what the miners call 'after-damp.' That is the gas which fills the mine after an explosion has taken place. For want of any other short expression, I shall speak of these products in this paper by that name. All gas heaters may be divided into two classes. One class sends this 'after-damp' up the chimney, and the other puts all, or a part of it, out into the rooms."

Dealing further with the latter class —*viz.*, "stoves, radiators, and fires without any pretence of a flue," as being decidedly most numerous, the speaker said: "These are admissible in rooms which are used only occasionally, or which are opened very frequently; or, by providing abundant ventilation, a fairly good atmosphere may be maintained in any room with this class of heater. For bed-rooms, for sitting-rooms, or any other close room

where the fire is burnt constantly and the windows kept closed, this class of heater cannot be condemned too strongly.

"Next comes the heater with the pretence of a flue; I say pretence, because most of the flues provided are totally incapable of carrying off more than a small fraction of the 'after-damp' and the air that mixes with it as soon as it is formed. I have seen a gas grate twenty-four inches wide provided with four ¾-inch round tubes to carry off all the products of combustion. The manufacturer had soothed his own conscience, and the purchaser, no doubt, congratulated himself on the good ventilation he would get; but, as a matter of fact, these tubes are able to carry off less than four per cent. of the 'after-damp' from this fire, and might just as well have been left out altogether.

"Another genus of this species of heater provides an ample flue with a damper to close it. The customer finds by experience that he gets very little heat when the damper is open, and consequently closes it tight and allows it to rust in that position.

"An open gas fire with a real flue (that is, a flue capable of carrying off all of the 'after-damp') is a class by itself, and can only be used in towns where natural gas is sold at a low price. It heats entirely by radiant heat, carries a large amount of air up the chimney, and is an excellent ventilator in every respect. It has only one draw back, and that is that, as it only utilizes about fifteen per cent. of the heat, its use is absolutely restricted to the fields where cheap natural gas can be obtained."

None of the objections attending the burning of gas in rooms without flues apply to gas burned in an ordinary furnace as a substitute for coal, and even the furnace without a flue is less objectionable than the first-named method, because, though it sends into the house all the products of combustion, it introduces a large volume of fresh air at the same time. A serious draw-back to this method is that, should the gas be extinguished, while continuing to flow, the unconsumed gas would flow directly into the apparatus connected with the furnace and thence into the house. This may happen, has happened in some instances, and is dangerous whenever it does occur.

"Heaters with real flues . . . . are rapidly finding favor with the public. With this class of heaters, having sufficient radiating surface, all the available heat except that required for draft can be utilized, and the ventilation can be made good by taking air from the floor and passing it through the fire." Mr. McDonald thinks it possible to utilize ninety-four per cent. of the available heat in this class of heaters.

Disinfecting Books.

MR. THOS. FLETCHER, F. C. S., in a letter to *Journal of Gas Lighting* (April 14), cautions the public against the use of gas-ovens for disinfecting books, as recommended by another correspondent; and declares that it is practically impossible thus to disinfect books without destroying them. He says: "Dry heat penetrates paper, woolen, and similar substances so very slowly that the minimum heat required—*i. e.*, 220° for at least four hours—is never attained, even in a very thin book, without the complete destruction of the outer part. The use of dry heat in gas-ovens has been so repeatedly proved to be useless for the disinfection of books, clothes, &c., that any attempt to reintroduce these appliances for such a purpose cannot be too severely condemned. This matter is fully dealt with in Whitelegge's 'Hygiene and Public Health'; and the total failure of gas-heated ovens for this purpose is well known to experts. A very simple experiment will show the difficulty. If a book is fastened so that the cover and leaves cannot curl open, and is then placed in the middle of a fierce fire, it will be found that the inner part is not even scorched after a long period; and the destruction of a pile of books by fire is a very difficult matter, even when they are turned over and raked, in order to expose fresh surfaces to the heat." He adds that the firm with which he is connected is frequently asked to make gas-ovens for disinfecting, but, knowing that such ovens will certainly fail of their purpose, orders for them are invariably declined.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Magazines and Journals—See Introductory

Heating and Ventilation.

5290. Ventilation of Gas-Heated Rooms. Donald McDonald (An exhaustive paper considering the subject of gas-lighting and gas-heating in its sanitary as well as economic phases, followed by a protracted, spirited and instructive discussion). Am Gas Lgt Jour–April 13. 7400 w.

*5483. On Church Heating. H. B. Prather (By the combination of steam indirect and blowers. Illustrated detailed description of an elaborate system. A good article). Dom Engng–April. 2500 w.

*5498. The Combustion of Coal and Gas in House Fires. J. B. Cohen and G. H. Russell (Read before the Yorkshire Section of the Society of Chemical Industry. An exceedingly able and valuable discussion of the subject from both scientific and practical standpoints). Gas Wld–April 11. 3000 w.

5507. Economic Utilization of Exhaust Steam. William J. Baldwin (Extract from pamphlet on the Separation of Grease from Exhaust Steam. This paper answers the following questions. (1) How hot can feed water be made? (2) What percentage of the coal does the heating of the feed water represent? (3) How much of the exhaust steam from an engine can be used in heating the feed water necessary to supply the loss caused in the boiler by supplying steam to the same engine? (4) How much of it is left for use elsewhere, partly or wholly, to heat the building in winter or for drying purposes). Heat & Ven–April 15. 2000 w.

5508. The Carbonizing of Wooden Lagging on Steam Pipes (Report of inspector F. L. Pierce, of the Boston Manufacturers' Mutual Fire Insurance Co., with excellent engravings illustrating the carbonizing of wood lagging on steam pipes, thus rendering it liable to spontaneous combustion, or at least greatly increasing its combustibility). Heat & Ven–April 15. 1200 w.

5509. Study of the Heating and Ventilating Plants in the Suffolk County Court House, and the Massachusetts State House, Boston. Percy N. Kenway (Read before the Boston Society of Civil Engineers. Very full illustrated detailed description). Heat & Ven–April 15. 5600 w.

5510. Ventilation of Schools as Affected by Poor Sanitary Apparatus (Abstract from the report of the expert committee appointed by Mayor Quincy, of Boston, to examine into the sanitary condition of the school-houses in Boston). Heat & Ven–April 15. 2700 w.

*5560. Insulating Underground Steam Pipes. Edgar Kidwell (The methods described by R. C. Carpenter, in a previous issue, are criticised as examples of "how not to do it," after which the writer illustrates a method which seems to him more efficient. His method is substantially the use of a wooden box sheathed exteriorly with copper, and having a space to be filled with mineral wool surrounding the pipe, which latter rests on cast-iron supports). Eng, Lond–April 10. 900 w.

5761. Estimates of Radiation. Knight (A simple, concise and reliable method for most cases is given, whereby the extent of heating surface for rooms differently located may be computed). Met Work–May 2. 1800 w.

5838. Ventilation and Lighting of the Buffalo Real Estate Exchange (Illustrated detailed description of a radical departure from the usual method of constructing a modern office building. The indirect system of heating is used throughout, and every room in the eleven-story building is ventilated. The ventilation is forced by blowers). Eng Rec–May 2. 2800 w.

5899. Steam Heating Plants. Norman (Experiences with plants using exhaust steam from elevators). Sta Eng–May. 900 w.

5922. Heating and Ventilating a Brooklyn Church and Chapel (Illustrated detailed description of a church heated chiefly by indirect radiation, with some supplementary direct radiation, and in which the ventilation is effected, both winter and summer, by a fan blower driven by a gas engine). Eng Rec–May 9. 1100 w.

Landscape Gardening.

5352. The Plans of Madison Square (Letters from S. A. and L. G. S. discussing the plans published in this paper and offering suggestions). Gar & For–April 15. 600 w.

5675. Madison Square Again. H. A. Caparn (A letter, with proposed plan, and points of merit of the plan). Gar & For–April 29. 350 w.

Plumbing and Gas Fitting.

5481. Areas and Discharging Power of Pipes. J. L. Bixby, Jr. (Plumbing for different diameters. Table of discharging power with explanation, part of which is especially applicable to hot water work). Met Work–April 18. 700 w.

*5482. How to Plumb Our Houses—Theory and Practice. H. C. Patterson (What every property owner or intelligent citizen ought to know in order to decide for himself what are his necessities, and how to get them with least expense and annoyance). Dom Engng–April. 2200 w.

*5483. A Hotel Header (Description of hot and cold water supply to eleven baths and three toilets). Dom Engng–April. 200 w.

Miscellany.

*5288. Treatment of Wall Stains. A. Ashmun Kelly (Deals chiefly with processes and means for removing unsightly stains). Plumb & Dec–April 1. 1200 w.

We supply copies of these articles. See introductory.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Domestic Engineering.

Vacuum-Tube Lighting Up to Date.

THE most interesting electrical paper of the current month is that read by Mr. D. McFarlan Moore before the meeting of the American Institute of Electrical Engineers (April 22) and printed in full in *The Electrical Engineer* (April 29). The paper—a very long one—was experimentally illustrated at the reading, and, as printed, is profusely illustrated by engravings. The importance of the subject, and its able treatment by the author, who has long been an ardent investigator in this field, demand more than an ordinary notice; yet we must despair of doing even small justice to it in the space that can be spared for it in this department. Much of it, however, if quoted, would be imperfectly comprehended, except by trained electricians, and these will doubtless peruse with care the whole of the paper. We can notice only a few points of more popular interest.

After an introduction indicating not only the possibility, but the near probability, of a system of lighting by vacuum tubes that shall rival sunshine, and possess the same qualities, the author says that "the new electric light should possess all the good qualities of the present lamp with none of its drawbacks," and that "among its improvements will be noted the combination of utility and decoration." The recognized tendency of the day is toward multiplication of lights and avoidance of strong shadows,—in other words, an even illumination, or light from all directions.

The object of the paper is to call attention not only to the advantages that will accrue with the adoption of vacuum-tube lighting, but more particularly to a simple method of obtaining a current which will ultimately make such an adoption feasible; and to this end the author describes "radical departures from well-beaten paths in principles, in apparatus, and in the nature of the current, resulting in a light of greatly-increased intensity." With this light the large hall in which the meeting was held was illuminated, greatly to the pleasure of the large and appreciative audience. The enormous difficulties which have obstructed the commercial success of the system were well portrayed. To surmount these difficulties, Mr. Moore has carried out a most carefully conducted and laborious series of experiments, the description and experimental illustration of which occupied three hours, and was listened to with profound interest. Not since Tesla performed his memorable series of experiments at Columbia College in 1891 has there been so remarkable a public display of experimental work in the electrical field. The author, in the introductory part of his paper, said:

"For many years the Geissler tube has been a scientific toy. When a suitable electric current is connected to its terminals, its entire length is filled with a faint glow. This is, of course, a light of radically different character from that now used in any commercial form of illumination.

"It is light emanating from rarefied air, with an apparent absence of heat and combustion. Upon this principle developed probably depends the light of the future, which will soon be, in the opinion of the writer, the 'light of the present.' As a device for transforming electrical energy into light, the vacuum tube is very efficient. The majority of authorities place it at about seventy per cent. and the incandescent lamp at two per cent. Notwithstanding this remarkable efficiency, it has never been commercially possible to illuminate

by vacuum tubes, because the light could not be made sufficiently intense (this is expressing it mildly), even with bulky apparatus that was entirely impracticable.

"Furthermore, the current produced by such apparatus was of such a nature as to render its insulation extremely difficult. The ordinary induction coil is often used for this purpose. A current of low voltage, such as that from a battery of a few cells, must be used with such a coil, because a current of higher voltage could not be properly disrupted, the arc forming preventing a sudden break of the current. But, since the light depends on the suddenness of the break, the arc must be prevented; therefore the quicker the break, the brighter the light—provided the apparatus is properly designed.

"The quickest break can be made by interposing in a circuit the most perfect dielectric in the minimum space of time. The best dielectric known is a vacuum, and I have discovered methods for interposing it in rapid succession in a current in a minimum space of time, depending upon the principle of making and breaking a current rapidly in a vacuum.

"The disruption of any current in the air results in the formation of a spark of greater or less length, and the greater its length, the less sudden the break. Therefore, if the break be made in a vacuum, the narrowest conceivable complete gap in the metallic conductor results in an almost instantaneous discontinuance of current, insuring a maximum c. e. m. f. The current is thus interrupted in an almost infinitely short space of time as compared with all the ingenious mechanical contrivances, such as air-blasts and magnetic blow outs devised for the purpose of breaking a current suddenly in the open air, but all of which are of little avail for the production of any quantity of light."

Having thus set forth the principle of the new system, the author next describes the vacuum vibrator which is "the nucleus" of his invention. It "consists merely of a spring rigidly supported at one end, and having attached to its free end a small disc of soft iron. A contact point rests against the spring at about its center. A sealed glass tube, from which the air is exhausted, incloses both spring and contact point. The system, as a whole, is exceedingly simple. An electric current passes through a coil of wire, and then through the vacuum vibrator. Wires in contact with the outside of each of the ends of a closed and empty glass tube are attached to the two ends of the coil of wire. This statement embodies the gist of the invention."

Attention is directed to the extreme simplicity of this device, as compared with means commonly employed for exciting luminosity in Geissler tubes. We pass over the technical part of the paper which follows, and quote the statement of some of the difficulties which have been encountered.

"Permit me to call your attention once more to the key of the whole system,—*viz.*, repeated interruptions of an electric current in a high vacuum.

"The simplest method of accomplishing this object is to hermetically seal within a glass tube a vibrator of ordinary form, but its exact construction, to give the best results, has been a matter of tedious experimentation and study. The very slightest alteration in the dimensions of almost any of its parts—such as the length, width, and thickness of the spring, or its method of mounting, or the position of the contact points, or the thickness or diameter of the armature—will cause it to be a very good or a very poor vibrator. Again, the operations of the glass-blower had to be watched most carefully. Only certain kinds of iron and steel were selected, to avoid occluded gases, and even then they must undergo a special treatment, before being fit for use. The selection of suitable contact points has also been a large field for research. Nearly all known conductors have been tried, and many interesting facts have developed in this connection, not only so far as the direct action on the various metals in vacua and various gases is concerned (and this in several instances is the reverse of the phenomena noted in open air), but also with reference to the electrodeposition or electrolytic action that takes

place. For instance, as is well known, the positive electrode is the one which disintegrates most rapidly in the open air, and its apex is usually concave. This is probably best shown in the ordinary direct-current arc lamps. If aluminum, or any soft metal of comparatively low fusing point be used as contacts in a vibrator, after about a day's run, an examination shows that the shape and condition of the contacts are just the reverse of the way they appear after use in the open air. That is, the positive terminal looks like the negative, and the negative like the positive."

The speaker said he had constructed a large number of "varieties or amplifications of the ordinary type of vibrator, such as multiple contacts, etc.," and he described and illustrated some of these forms. He then entered upon the scientific theory of the unique properties of vacuum vibrators, which part of the paper we also pass, closing this review with a statement of some practical applications of this light which are anticipated.

"I may be pardoned for calling your attention to the remarkable intensity of the light in these tubes, in connection with the statements repeatedly made by eminent scientists that such intensity was an impossibility, and that efforts in this direction were comparable to those wasted on perpetual motion.

"The very nature of the light, if it is to be a counterpart of the ideal daylight, is such that, when a square inch of the surface of the tube emits as much light as that thrown into a room through an aperture one inch square, the want is satisfied. Then the desired illumination can be reached by multiplying the area and length of the tubes, and distributing them in the most advantageous manner,—that is, so that the light will fall from all directions. When a considerable area is to be lighted, the most efficient light is the one that is most equally distributed. However, there will always be a demand for units of light. Even this can be satisfied by using a tube of small caliber. This lamp is made by winding a small tube in the form of a spiral, its ends, to which the wires are attached, terminating in oblong bulbs three or four times the diameter of the small tube.

"I have previously stated that the alphabet has been constructed of tubes of light. Here are the initials of the body I have the honor to address, A. I. E. E., in letters twelve inches high. The delicate shades of these letters cannot fail to elicit admiration from all who love the beautiful.

"The principle of breaking a circuit in a vacuum has many applications to a variety of uses. Among them may be mentioned advertising signs, decorative electric lighting, electro-therapy, philosophical apparatus, theatrical effects, in the manufacture of ozone, in the kinetoscope, etc., etc.

"But the greatest field will ultimately be that of general illumination. You have noticed the tubes extending around this hall. Undoubtedly this is the first time that lighting by tubes has been attempted on so large a scale. You will note the almost entire absence of shadows."

Conductivity of Cement and Concrete.

LEAKAGE currents from the returns in electric tramways have always existed, and probably always will exist to some extent, no matter what effort may be put forth to prevent leakage. They are, however, less than they were in the infancy of electric-railway practice, and they will doubtless be still further reduced. In an abstract from a paper printed in *Elektrotechnische Zeitschrift* (March 19), *The Electrician* (April 10), quoting from the author, Dr. St. Lindeck, says that, of proposed remedies, "those should be preferred which attack the evil at its root,—that is to say, diminish the leakage from the rails, and consequently remove all disturbances at the same time." To this end effort to increase resistance "between rail and earth" is obviously in the line of progress, and Professor Ulbricht, in a prior contribution to the *Elektrotechnische Zeitschrift*, expressed the belief that, "even if we retain the return rail system, there are a number of ways of reducing the disturbances to a permissible

amount." It is also obvious that a first step toward any exhaustive study of the problem is the determination of "electric conductivity of materials used for the foundation of electric tramlines."

Dr. Lindeck has therefore been experimentally investigating the conductivity of pure cement, concrete made of cement and sand, and concretes of cement and gravel in different proportions. He used parallelopiped blocks of cement, and of concrete. These blocks were 10 c m. × 10 c m. in section, and 40 c m. long; electrodes of perforated sheet iron with protruding ends were imbedded in the blocks. The resistance tests were made with a plug resistance box and a battery of ten small accumulator cells, the block to be tested completing the circuit. This description only indicates the general character of the method, and is not intended to cover all the details. The results are given in tabulated form, and the article itself must be consulted for these data. The results indicate, however, "that the electric resistance of cement blocks and blocks made of cement and sand or gravel when in an air-dry condition is relatively small; it is lowest of all in the case of pure cement, and becomes higher as more sand or gravel is mixed with the cement. The porosity of the material increases, however, in the same proportion, as can be seen by the decrease in the resistance after the blocks have been put under water for some time. In this way the resistances of cement blocks fall, after being under water for about one day, to one-third of the resistance shown when in an air-dry condition. In blocks containing one part cement and three parts sand, a two-hours' immersion is sufficient to bring the resistance down to one-tenth of the original. And in the two kinds of concrete the resistance of the blocks, when moist, drops to about one-twentieth.

"On the basis of these tests one cannot but come to the conclusion that the arrangement of the road-bed of electric lines must be very favorable to leakage, especially where the concrete on which the rails rest is covered with a layer of asphalt, which latter prevents a good drying of the concrete. The extent to which concrete retains moisture can be seen from the tests made on the blocks after they had been heated to over 100° C. for several hours. For instance, the resistance of a 1-decimeter length (1 decimeter square) of the compound, consisting of one part cement and seven parts gravel, rose to 6 or 7 megohms while in an air-dry condition, and three months after the manufacture the resistance was only 5,000 ohms. Similar results were obtained with the other concretes, but, after one month's exposure to air, the resistance fell to one-third of this figure.

"In the cement blocks the change of resistance due to heating was small compared with the compound blocks. The resistance rose at first to 1,000 ohms, and further, after one month, to about 2,000 ohms.

"If, for the purpose of an approximate calculation, the resistance of concrete in dry air is taken at about 5,000 ohms per 1 dm., sq. dm., a tramline put down on concrete would have a resistance to earth of under 1 ohm per kilometer.

"Prof. Ulbricht's communication directed attention also to asphalt-concrete, a material used to some extent for building purposes in Dresden. The same form and arrangements as for the other materials were adopted for this material, and the tests were made together with the others. Asphalt-concrete consists of 50 per cent. of stone chippings, 20 per cent. of rough gravel free from loam or sand, 12 per cent. of asphaltic mastic, 8 per cent. of pitch, and 10 per cent. of German tar. The composition of the material can, however, be varied as desired.

"It would be of little use to record here all the tests of the different blocks, as there was always an extremely high resistance, and one could never be sure whether one was dealing with the conductivity of the material, or only with surface conduction. For instance, a block made with 'Syenit' chippings gave in dry condition per 1 dm., sq. dm., 380,000 megohms. The block was then placed under water for 2 hours, and, after having been again in the air for 2½

hours, it still showed a resistance of 160,000 megohms. Even after the block had been continually under water for 6 weeks, it still gave an insulation resistance of 17,000 megohms. Similar results were obtained with other blocks of asphalt-concrete. The material is, therefore, practically waterproof."

Summing up, it appears most probable that, by using asphalt-concrete, the rails could be permanently insulated from earth to such an extent that leakage currents of any importance could not occur. The asphalt-concrete should be laid in a thin layer over the cement-concrete, so that the cost of a line would not be appreciably increased.

Arc-Lighting Practice.

ONE of the best practical electrical papers printed during the current month is an article contributed to *Electrical Engineering* (April) by Mr. Alex. Dow. It is a general review of arc-lighting practice in America, with brief reference to an excellent paper by Mr. John Hesketh (*Electrical Engineering*, Feb.).

As Mr. Dow is the electric engineer of the public lighting commission, Detroit, he is in a position to speak authoritatively.

As regards carbons he states that only recently, and coincidently with "the introduction of arcs on constant potential systems," the use of "imported carbons, with cores of differing diameters, began"; and he asserts that "the alternating arc was a rank failure until a proper carbon and 30- or 33-volt adjustments were adopted." In this and in other respects practice in arc lighting has much improved.

"The ½-inch coppered carbon still holds the field in street lighting, and is likely to hold it for some time to come. The practice of using partly-burned uppers in the lower holders, and double carbon lamps for all-night street lighting, are the factors of greatest importance in deciding this, because they require the purchase of but one size of carbon (usually 12 inches long, but ½ inch diameter), and yet allow of every piece of carbon being fairly burned out,—the short lengths produced at one season being mated and reissued to the trimmers at another. The worst fault of the ½-inch carbon plan is the 'lapping' of points during the run,—that is to say, the dropping of the upper carbon past the point of the lower, causing a short arc or total extinction. If the current is a trifle high, so that the conical points are longer than normal, or if the carbons are a little crooked, this trouble may become serious. Lamps on towers, or other supports much affected by wind or vibration, are specially liable to it."

In the plant operated by Mr. Dow, "an analysis of the 'outs' for two months showed that lapping was responsible for too much of the total trouble. We were running with $\frac{7}{16}$-inch (11 mm.) carbons in both holders, and a large number of lamps were in towers, while still another large number were on poles to which electric street-railway span wires were attached. We changed to $\frac{5}{8}$-inch (16 mm.) uppers, retaining the $\frac{7}{16}$-inch lowers. Result for four winter months' operation of 1,480 street arcs is just one 'out' by lapping. We cannot see any practical difference in the total light. Experiments show a little difference, but it is negligible in comparison with the improved reliability."

For interior lighting the uniform carbon has permanently gone out of use. On this point Mr. Dow says: "I have only a dozen interior lamps—the incidents of a plant installed primarily for street work; but these dozen use three different carbons,—to wit: 13 mm. American-made cored uppers with 13 mm. American solid lowers, forced, and not coppered, these being pairs for 45 volts by 9.6 amperes direct-current arcs, and 13 mm. 'Electra' cored, for alternating 30 volts by 15 amperes arcs. It is not unusual nowadays to find a station carrying in stock ten different carbons for interior work; and the use of uppers of larger diameter than the lowers is frequent, though not yet general. I fear that the refinements found in the best European carbon practice will (like the best of the European arc lamps) never acquire a permanent footing here. The effort to systematize, which has reduced constant current series arcs throughout the

United States to two standard currents, 9.6 and 6.8 amperes, will reduce carbons to a very few sizes and styles. To our central-station men life is too short to fuss with lamps of the delicacy of chronometers and with carbons of different sizes for each month in the year.

"I notice, however, the differentiation of the street-lighting lamp from that rented to private patrons. It is not long, say three years, since the total difference was in the style of the jacket; the street-lamp jacket was japanned iron, while the private customer's lamp was done up in brass. Now the difference is radical. I have already noted it in carbons. In mechanism the private lamp (if I may so call it) is frequently a shunt wound lamp, if run on a series circuit, and often it has a rack feed. The public lamp is usually differentially wound, and almost always has a clutch feed. The difference in mechanism extends even to the adjustment of individual lamps, the station lampman cultivating a feed by imperceptible movements for the private lamp, which the said lampman calls a 'sneak' feed, while on the public lamp he adjusts for a 'drop' feed,—that is to say, he tries to have the clutch kick itself entirely clear of the rod at the instant of feeding, causing a *drop* rather than a *slide* of the upper carbon, and the regulating magnet is relied on to immediately adjust the arc to the proper length when the clutch gets its new hold."

The reasons given for this differentiation and the remarks upon the pronounced differentiation of the outward appearance of the public and the private lamp are interesting, and the prediction with which the author dismisses the subject of lamps —to wit, that arcs maintained in an inert atmosphere will be the feature of private lighting for the next-year seems entirely justified by recent progress in this line. He also thinks that the rectifier will soon be introduced in American practice, and hopes that its usefulness will be extended from the 60-light machine to larger sizes, —naming 100-light and 125-light as probable sizes. He bases this opinion upon the experience of Mr. Hesketh, with a 60-light Ferranti rectifier, wherein 73 per cent. efficiency was attained, and states that he gets identically the same efficiency; and he adds: "I do not question that the rectifier is more efficient than a 55-light Brush set."

The necessity for 100- or 120-light series circuits exists in American street lighting, and 5,000 or 6,000 volts may be used advantageously in transmission, "even at some sacrifice of station efficiency, and even when coal is but $2.25 per ton of 2,000 pounds.

"The economy of never running an underloaded engine can only be secured by the use of smaller engines, in place of large, which latter, no matter how refined in their construction, can not be used economically, when not running at or near full load. If the arc-lighting engineer will understand that his extra boiler capacity had better be standing idle, but ready to fire on a moment's notice, and that his big cylinders had better be traded for others of half the piston area to fit the same engine-bed and shaft, he will have learned the first and greatest rule of central station economy." It might be added that this lesson needs to be learned in many central stations.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical, and Engineering Journals—See Introductory.

Lighting

*5265. Development of Electric Lighting Engines. H. Lindley (Showing the considerations and improvements that have led to the substitution of engines of moderate and high speed for those of slow speed, in electric lighting work). Eng Mag-May. 2800 w.

5283. The Incandescent Lamp. George White Fraser (A review of the history of the invention, with an account of tests, and drawing conclusions that will suggest the proper way to purchase and the proper way to run them). Can Elec News-April. Serial. 1st part. 2400 w.

5284. Railroad Station Lighting Plant at Syracuse, N. Y. (Illustrated description). W Elec-April 11. 500 w.

*5348. Public Lighting by Arc Lamps. André Blondel (The writer purposes making a close examination of the means actually employed in the production and utilization of this

We supply copies of these articles. See introductory.

source of light, indicating possible improvements). Elect'n–April 3. Serial. 1st part. 2400 w.

5363. Arc Lighting Practice. Alex Dow (Some reference to comments of Mr. John Hesketh on arc lighting practice in England, with other matter of interest on the subject). Elec Engng–April. 3400 w.

*5371. Systems of Wiring. Joseph T. Monell (Lecture delivered before the Henry Elec. Club. Considers the various systems and their advantages and disadvantages). Elec Pow–April. 2300 w.

5432. Some Advantages of Electric Light. George D. Shepardson (A paper read before the Minnesota Chapter of the American Inst. of Architects. The various methods of using the electric light both for illumination and illumination appearance are dwelt upon and the advantages stated). Imp Bul–April 17. 1600 w.

5494. The New Three-Phase Electric Lighting System of Salt Lake City (Illustrated description). Elec Eng–April 22. 1800 w.

5511. Electricity in Horticulture. Ill. (Abstract of a report made by L. H. Bailey on the experiments carried on at Cornell University with a view of determining the influence of electricity in horticulture). W Elec–April 25. 1800 w.

*5539. New Electricity Works at Islington (Descriptive. The principal feature is the provision that has been made for easy extension and increase in capacity of the station without any inconvenience or interruption to the supply). Elec Plant–April. 5000 w.

5676. Recent Developments in Vacuum Tube Lighting. D. McFarlan Moore (Paper read at the meeting of the Am. Inst. Elec. Engrs. The object of the paper is not only to call attention to the advantages that will accrue with the adoption of vacuum tube lighting, but more particularly to a simple method of obtaining a current which will ultimately make such an adoption universally feasible). Elec Eng–April 29. 8300 w.

*5794. Experiments with Accumulators for Lighting Railway Carriages. G. Klose (Examinations of systems of accumulators made in a series of experiments carried out by the Hungarian State Railways during the past year, on the lighting of railway carriages by electricity). Eng, Lond–April 24. 600 w.

5865. The New 28th Street Station of the United Electric Light and Power Co., New York (Describes and illustrates the building, boilers, engines, dynamos, exciters, feed pumps, electric crane, coal and ash conveyor, piping, switchboard and switch gallery). Elec Eng–May 6. 3400 w.

5868. An Instrument for Directly Measuring the Mean Spherical Candle-Power of Arc Lamps or Other Luminous Sources. Edwin J. Houston and A. E. Kennelly (Description of an apparatus capable of giving direct measurements of the mean spherical candle-power of a luminous source. By the use of this instrument it becomes possible to measure at one observation the total quantity of light emitted by an arc lamp at any given electric activity). Elec Wld–May 9. 1500 w.

5869. The History of Electric Lighting. Francis B. Crocker (Review of the subject from its earliest beginnings to the present, showing progress. The three most prominent systems are briefly explained, and the possibilities of improvement considered). Elec Wld–May 9. 3700 w.

5912. Report on Municipal Ownership of Electric Street Lighting Plant for Utica, N. Y. (The committee of the Common Council after quite a discussion and reviewing the experience of other cities, concludes that the service can be secured quite as cheaply by private contract. But the appointed electrical engineer in his report, strongly recommends municipal ownership). Eng News–May 7. 900 w.

Power.

*5267. Electricity and the Horseless-Carriage Problem. Wm. Baxter, Jr. (Comparing steam, oil, gas, and electricity as motive powers for automobiles, and maintaining the superiority of the electric storage battery for this purpose). Eng Mag–May. 3300 w.

5285. Electrical Station Economy. Dr. Rasch, in *L'Industrie Electrique* (Showing that the capital invested in electric lighting alone is not properly utilized. Discussing the charges for power and light, and the arrangements made in effort to overcome injustice and difficulties). W Elec–April 11. 1500 w.

*5293. The Westinghouse Electrical Works (Illustrated description). Engng–April 3. Serial. 1st part. 1800 w.

5361. Electricity and Water Power. Mark A. Replogle (The writer aims to put into plain language the fundamental principles by which electrical phenomena are explained). Elec Rev–April 15. Serial. 1st part. 1700 w.

*5372. Systems of Dynamo Regulation. Joseph Sachs (Edited by W. H. Freedman from the stenographer's notes of a lecture delivered before the Henry Electrical Club. A consideration of the various methods and their modifications). Elec Pow–April. 2000 w.

5381. Niagara Model for the Electrical Exposition. Orrin E. Dunlap (Illustrated description of a beautiful model of Niagara in miniature, to be exhibited at the forthcoming electrical exposition to be held in New York). W Elec–April 18. 1400 w.

5383. Model Factory Electrically Operated (An illustrated description of the power plant of the Northern Electrical Manufacturing Co., at Madison, Wis.). W Elec–April 18. 700 w.

5384. Transmission of Power in Factories. J. J. Flather (A consideration of the subject favoring the driving of machines by means of electric motors). W Elec–April 18. 1300 w.

5491. Electric Power in Brick Yard and Foundry. F. M. Tait (Illustrated description of the power plant lately installed in the works of the Lehigh Fire Brick Co., of Catasauqua, Pa., with brief mention of plant installed at the works of the Davies & Thomas Co., East Catasauqua, Pa). Elec Eng–April 22. 800 w.

5492. The Trenton Falls and Prospect Water Power Development. Orrin E. Dunlap (Description of the locality with account of its power possibilities as given in the report of Mr. Wallace C. Johnson. General plan of development, etc). Elec Eng–April 22. 1600 w.

5493. California Water Power in Electrical Harness. H. G. T. (Abstract from correspondence in the *N. Y. Evening Post*. Brief review of the work already done and in prospect in this line). Elec Eng–April 22. 1800 w.

*5538. The Generation and Distribution of Current by an Edison Station. J. W. Lieb, Jr. (Paper read before the N. Y. Electrical Society. Reprinted from *Electricity, N. Y.* Historical account of the development of the company and description of station, &c). Elec Plant–April. 4500 w.

*5570. Experiments Upon Friction in Electric Motors and Transmission Shafting (Review of article published in the Inst. Civ. Engs. Foreign Abstracts, giving an account of experiments made in electric motors and transmission shafting in the electro-mechanical laboratory of the Ecole Spéciale d'Industrie et des Mines, at Hainaut. The methods followed, with a view of determining between what limits the power absorbed by subterranean transmission shafting varies, are capable of general application). Mech Wld–April 17. 800 w.

*5586. The Rhône Hydro-Electric Installation (Illustrated description of an undertaking on a large and very comprehensive scale, the object of which is to convert the water power of the Rhone into electric energy, to be distributed throughout the city of Lyons, and adjacent districts). Engng–April 17. 3500 w.

5656. The Operation of Compound Wound Generators in Parallel. J. E. Woodbridge (A study of the action of a plain shunt-wound machine and a simple series wound machine, the compound-wound dynamo being a combination of the two). Elec Ry Gaz–April 25. 2000 w.

5657. The Elementary Principles of the Rheostat, Commutated Field and Series-Parallel Methods of Controlling Railway Motors. William Baxter, Jr. (The general principles will be explained in these articles, and the way in which they are applied by several of the leading manufacturers will be illustrated and described by the aid of the wiring plans they furnish). Elec Ry Gaz–April 25. Serial. 1st part. 2000 w.

5660. Electrically Operated Bicycle Works (Illustrated description of the Miami Cycle & Mfg. Co. of Middletown, O. In addition to the load at the works the generator supplies current to lights throughout the town). Ir Tr Rev–April 23. 800 w.

5686. Electric Propulsion by Subterranean Conductors. From *La Nature* (Notes on the different systems of subterranean conductors in conduits for electric propulsion, with illustrations of some of the most important). Sci Am Sup–May 2. 1500 w.

5722. The Twenty-Eighth Street New York Station of the United Electric Light and Power Company (Illustrated description). Power–May. 3000 w.

5723. Generators Run as Motors. William Baxter, Jr. (The cause of fly-wheel accidents in electric stations). Power–May. 3400 w.

5816. Electric Power for Mines and Iron Works. Carl Pfankuch (Read at a recent meeting of the German Ironmasters' Association. Abstract giving the writer's idea of the saving that could be obtained by the adoption of electricity as motive power, and where it could be most advantageously applied). Am Mfr & Ir Wld–May 1. 1100 w.

5846. Electrical and Mechanical Equipment of the Milwaukee City Hall (Illustrated description of a very completely equipped building). W Elec–May 2. 2000 w.

5866. The Electrical Plant in the Siegel-Cooper Co.'s "Big Store," New York City (Illustrated description. Electricity is utilized for light, heat, power, ventilation and as a means of attraction). Elec Eng–May 6. 3800 w.

5870 Little Economies in Central Station Practice. Thomas G. Grier. Read before the Chicago Electrical Association (A compilation of points suggested by correspondence with a number of central station men). Elec Rev–May 6. Serial. 1st part. 1400 w.

†5890. Distribution of Electrical Energy from a Central Station. Ill. William C. L. Eglin (Dealing with the distribution of electrical energy in large cities using underground conductors with a continuous supply—twenty-four hours per day, and seven days per week. The energy to be supplied in such a form as to meet all the commercially practical uses to which electrical energy may be put). Pro Eng's Club of Phila–April. 4000 w.

5895. A Series-Motor Controller and Reversing Switch (Illustrated description of a controller designed with particular reference to the requirements of the traveling cranes of the Morgan Engineering Co., of Alliance, O., and produced by them). Am Mach–May 7. 1100 w.

5896. Torque and Counter-Torque, Electromotive Force and Counter-Electromotive Force (The terms given in title are explained, and examples of their action given). Am Mach–May 7. 600 w.

5911. The Folsom Sacramento Electric Power Transmission Plant (Illustrated account of the electric plant in detail). Eng News–May 7. 1100 w.

Telephony and Telegraphy.

*5345. Colonial Cable Communication and the Projected Pacific Cable (A discussion of this important subject. The first part is mostly a review of what has already been done toward finding best route, &c). Elec Rev, Lond–April 3. Serial. 1st part. 5000 w.

5365. Telephone Service—Its Proper Use. Fred DeLand (The relation of the telephone to business is the theme). Elec Engng–April. 1000 w.

*5433. A New French Trans-Atlantic Cable (From *L'Electricien*. The text of the report made by Mr. Boudenvot, in the name of the Budget Commission. Considering the establishment of

direct and reliable communication between France, the United States, and the West Indies). Elec Rev, Lond–April 10. Serial. 1st part. 1800 w.

*5434. Concentric Cables (A brief letter of inquiry from P. S. Clay calls forth an Editorial reply of some length on a point in connection with concentric cables). Elec Rev, Lond–April 10. 1400 w.

*5436. International Telegraph Conference of 1896 (Suggestions to the delegates to the meeting to be held at Buda-Pesth on June 16, favoring centralization of management). Elec Rev, Lond–April 10. 1200 w.

*5541. The Development of the Telephone System (Editorial discussing the attitude of the government to the telephone interests in England). Ind & Ir–April 10. 1500 w.

*5646. Safety Devices for Telephone Circuits. F. Mertsching (Abstract from the *Elektrotechnische Zeitschrift*. An account of some instructive experiments made in Germany, with a device for putting broken telephone wires, when they break in the vicinity of trolley lines, immediately into good contact with the earth). Elect'n–April 17. 900 w.

*5648. Gear for Japanese Submarine Cable Steamer (Illustrated description of a combined picking up and paying out gear, for the new submarine cable laying vessel of the Japanese government). Elec Rev, Lond–April 17. 900 w.

*5796. Combined Cabling and Serving Machine (Illustrated description of a machine for cabling gutta-percha covered cables, and at the same time serving them with compounded tape. The machine is arranged for cabling seven wires, —*i. e.*, laying six wires around one, and at the same time laying a yarn in the recess formed between each pair of wires, so that when the cable is taped it forms a more perfect round). Eng, Lond–April 24. 400 w.

*5856. Telephony and Telegraphy. N. Amzan in *L'Eclairage Electrique* (Discussing the possibility of utilizing the secondary telegraph lines for telephonic conversations. The first part considers alternate telegraphic and telephonic communications, and simultaneous telegraphic and telephonic communications). Elec Rev, Lond–April 24. Serial. 1st part. 2000 w.

Miscellany.

*5346. Recent Experiments with the Globular Discharge (The first part is descriptive of experiments for investigating by artificial production this peculiar phenomenon). Elec Rev, Lond–April 3. Serial. 1st part. 3000 w.

*5347. The Graphic Representation of Vector Potential. H. N. Allen (The object of the paper is to show how the distribution of electromagnetic vector potential can in certain cases be represented graphically). Elect'n–April 3. 900 w.

*5370. The Electric Cell. Ill. W. P. Jones (A brief glance into this field, dwelling on the points the writer has been most frequently asked to make clear). Elec Pow–April. 1000 w.

*5438. Experiments on the Hall Phenomenon in Bismuth. Dr. A. Lebret (Investigations made at the physical laboratory of Leyden under Prof. Kamerlingh Onnes' guidance). Elect'n–April 10. 2400 w.

*5439. On the Electric Conductivity of Cement and Concrete. Dr. St. Lindeck (Abstract from the *Elektrotechnische Zeitschrift*. Communication from the Reichsanstalt. The writer thinks it appears most probable that by using asphalt concrete the rails could be permanently insulated from earth to such an extent that leakage currents of any importance could not occur). Elect'n–April 10. 1000 w.

*5440. A Method of Measuring the Loss of Energy in Hysteresis. G. F. Searle (Paper read before the Cambridge Philosophical Society. A method for determining the hysteresis loss by a single observation of the "throw" of a spot of light along a scale). Elect'n–April 10. 1200 w.

5475. Advantages of Grooved Armatures. William Baxter, Jr. (The main point of superiority of the grooved armature is that it provides a perfectly rigid support for the wire. Other advantages are also shown). Am Mach–April 16. 2300 w.

5514. How to Use a Voltmeter as an Ammeter. George T. Hanchett (Illustrated description). Elec Wld–April 25. 1800 w.

5569. Electricity Direct from Carbon. C. J. Reed (An article written in refutation of the ideas set forth in a recent paper by Dr. Alfred Coehn. The writer claims that he did not prove electricity could be obtained direct from carbon, but rather that carbon was obtained from electricity, and points out errors). Elec Wld–April 25. 900 w.

5691. Mechanical and Electrical Work and Power (A discussion of the agreement between mechanical and electrical power). Am Mach–April 30. 1500 w.

*5730. Blasting in Pole Line Construction. I. J. Macomber (Description of a piece of work in charge of the writer, where nearly half the distance required rock blasting in setting the poles, showing the necessity of carefully examining the route of a proposed pole line, before making a final estimate of cost). Sib Jour of Engng–April. 1500 w.

5745. Fourth Annual Report of the General Electric Company (Reports of Pres. C. A. Coffin, 1st Vice Pres. Eugene Griffin, and 3d Vice Pres. E. W. Rice, Jr., with editorial). Elec Wld–May 2. 2800 w.

5753. The Steam Plant of the National Electrical Exposition (A brief illustrated description of a plant especially designed by a committee appointed for the purpose, to be a strictly modern plant, containing only the latest appliances). Eng News–April 30. 900 w.

5871. On Determination of Grounds on Alternating Current Circuits. R. O. Heinrich (The use of an electrostatic voltmeter for this purpose is explained, also the direct reading voltmeters of the electro-dynamometer type, such as the Weston, and the advantages of the latter are shown. A numerical example is given to illustrate the operation). Elec–May 6. 2000 w.

INDUSTRIAL SOCIOLOGY

Is Underselling a Crime?

THE affirmative of this question is supported by Mr. E. J. Smith in *Machinery* (London, April 15), in an article entitled "A New Remedy for an Old Evil." Mr. Smith is the head of the Bedstead-Makers' Association, a notable organization based on the following simple propositions.

"There is only one honest way of doing business,—to make the best article you can for the money, and make some profit out of the transaction. You have no right either to cheat your customer, or ruin your competitor by selling goods at less than it costs you to produce them. We are told that capital has a right to run risks, and sell for awhile at a loss, in order to make a connection,—that is, that rich men have a right to take away the customers of poorer and honester men by beginning to sell at prices which they cannot continue. Capital has no right to do anything of the kind; and, if the laws of the country will not prevent it, common sense and good organization must. If honorable-minded employers cannot prevent it among themselves, they must call in the services of their work-people, and pay them for the help they give. There is justice as well as reason in this course. Both sides have suffered by the practices of the past; both sides must help to remove the evil; both sides must benefit from the result."

In an address recently delivered by Right Honorable J. Chamberlain, the British colonial secretary, he spoke of this movement as follows:

"I don't know whether you are aware that within the last year or two he [Mr. Smith] has carried out in connection with the trade with which he is connected a great social experiment, the results of which have been truly marvellous. In a trade in which, formerly, every one, whether workman or employer, was dissatisfied, he has brought contentment. Wages, I believe, have been increased, profits have become larger, and, curious to relate, the demand and the production have also increased at the same time. This experiment, I believe, is capable of great development. I understood, when I was last in Bradford, that a great trade in that city, acting on Mr. Smith's suggestion, has agreed to adopt the principles upon which he has secured success. Those principles involve a hearty union between employers and employed; and I trust that all who find themselves in a difficulty will, at all events, give some consideration to the solution which Mr. Smith believes that he has found. I am always glad that a new light should proceed from Birmingham and, if Mr. Smith is successful in dealing—as I think he may be—with many of the most urgent of our social problems, he will have gained from us an additional claim to our gratitude and our respect."

In an editorial calling attention to the movement and also to Mr. Smith's article, *Machinery* says:

"This gentleman claims to have solved one of the greatest social and economic problems of the day,—that of making a profit in business and insuring labor its share in it. All new movements of this kind arouse hostility. The political economist distrusts them. Trade rivals denounce them. The public looks on with practical indifference, tempered with a belief, carefully instilled by the enemies of the movement, that restriction and higher wages mean ultimately higher prices to the consumer. In spite, however, of all the obstacles which we have mentioned, and the *vis inertiæ*,—that inert opposition which ignorance and prejudice invariably offer to any innovation in the ordinary relations of labor and capital,—Mr. Smith's ideas have fructified; they have taken definite form; they have been tested; they have, it is claimed, succeeded. In fact, the claim is established and vouched for by the fact that numerous bodies and manufacturers have formed associations on the lines laid down by the chairman of the

bedstead makers' organization."

The details of the operations of the Bedstead-Makers' Association are promised for a future number. The article under review is confined to the main question: is underselling a crime? At the present time both in England and America it is not legally a crime, but Mr. Smith holds that it should be made legally criminal, being in his opinion morally culpable. Reduction of profits means always an ultimate reduction of wages. It also means deterioration of product, and both these are public evils. Mr. Smith says:

"That the underseller is not a criminal legally, at present, is a matter to be deplored, but that he is so morally seems beyond question. It is true that it is possible for some traders to do a large amount of underselling, and still continue to pay their creditors twenty shillings in the pound. It is also true that fortunes have even been made by some special kind of underselling. It is, however, impossible to judge of the morality of an action from the measure of its success in special instances. Success to one individual frequently means ruin to many others. There must be a principle upon which trading should be carried on, and that principle cannot be to sell articles at the same price, or less, than the cost of production. That inventive genius may originate better methods and improve processes of manufacture, which, by cheapening the cost of production, will very properly turn the current of some trade into one particular direction, is a matter of course; but this is not underselling in the criminal sense. Ingenuity and enterprise in business must be followed and imitated, or the stupid or sluggish must suffer. Moreover, every opportunity must be given to industry and ability in business, and any scheme which aims at fettering—or limiting—either cannot be universally adopted, or be successful for long. But every business man must know that these are not the causes of the underselling which ruins manufacturers, and drags even the skilled workmen down to starvation wages. This kind of underselling arises from two causes only,—ignorance and recklessness. Possibly both are not equally criminal; but both are criminal, nevertheless. Any trader having to meet his creditors from either of these two causes, and not being able to satisfy these creditors' lawful claims, is a dishonest trader, and should be recognized as such by the laws of the country. The time will yet come when we shall follow the example of some other countries, and make this a criminal offence. It must be remembered that the effects of this criminal underselling do not stop with the underseller,—or even with his creditors. He has probably succeeded in dragging down a trade to his own level. He has prevented honest men from gaining an honest living. He has flooded the market with an article for which, after all, there can only be a certain demand, and has injured—perhaps ruined—the competitors who wish to do a legitimate trade. Also, unfortunately, the meeting with his creditors seldom ends his dishonest career. A composition is generally accepted, and he is permitted to continue for a further period a course which leaves ruin and misery in its train. It is a scandal and a disgrace that such persons should be permitted to harass legitimate trading in a country which enjoys its great freedom because of its restriction of unwarranted license."

We are sorry that Mr. Smith's present article does not present material for a full outline of the working of the association; but, as he has promised this in a future article, we shall hope to give such an outline in a subsequent review.

Eastward "The Star of Empire Takes Its Way."

THE world has awakened to the fact that, with the shaking off of the fetters of ages in Japan, a new era has dawned for the entire Mongolian race. Japan is to the neighboring Mongolian States what Britain in the sixteenth century was to Ireland and Scotland, and the influence of her advancing civilization and her progress toward free institutions will be found as irresistible in China and Corea as that of Britain was upon the barbaric tribes of Ireland and the Highland clans of Scot-

land. The present generation has witnessed the dawn of a great oriental civilization. Statesmen, economists, historians, and politicians are viewing this wonderful movement with almost breathless interest. The rapidity and force of the Japanese advance are unparalleled in the history of the world.

The way in which this movement is regarded in England, the birth-place of free government, is easily gathered from editorials, speeches, and board-of-trade reports. Whatever faults are peculiarly English, blindness to the interest of her great commerce cannot be numbered among them; and it is evident from the tone of discussion upon oriental progress that the British government keeps a most alert watch on the progress which the Japanese are making in the arts both of war and of peace.

Under the title "Industrial Problems in the Far East," *Engineering* (April 3) says:

"The rapid changes and the solid progress made by Japan during the past quarter of a century are unique in the history of the world, and afford a most instructive lesson as to what a nation can do when it makes up its mind not to drift along in an aimless manner, but to work out its own destiny in its own way and according to its own ideas. Nothing has been more remarkable than the growth of an intelligent public opinion in Japan, as is evidenced by the great and rapid development of the newspaper press. A quarter of a century ago newspapers were practically unknown in the country; now there are hundreds of them, which are eagerly read by all classes of the community. During the recent war the patriotic feeling which was evolved was most intense, and the nation rose in a body to support the action of the government. The spirit which animated the army and the navy partook almost of the nature of that of the crusaders, and became religious faith which impelled them to deeds of daring and endurance. When this was backed up by effective organization and equipment, the Chinese, who were badly armed and led, and were wanting in patriotism, found them irresistible. While those who knew the Japanese were prepared for brilliant feats of arms on their part, they did not expect such an utter collapse on the part of the Chinese,—a result which has proved that the government of the country is in an entirely demoralized condition. Should the war prove to have been the means of arousing the national spirit of China, it will be impossible to estimate the ultimate results. When hostilities broke out, it was evident that public opinion in England was in favor of China, and Japan was looked upon as a wanton aggressor; but, as the *Times's* special correspondent recently pointed out, facts have been disclosed which prove that China has for some years contemplated the invasion of Japan, and that the preparations for it were intrusted to Li Hung Chang. That astute personage did not at all object to the project; he simply urged that it would be a mistake to assail the intended enemy too hastily. All this was perfectly well known to the Japanese statesmen, and they took the opportunity of bringing matters to a crisis, and of showing her rival that the naval and military power of Japan was not to be despised in the manner in which it usually was by the Chinese.

"The immediate results of the war are already very apparent. It has not only caused the naval and military power of Japan to be recognized, but it has also directed attention to the great development which that country has made in many departments of industry, and led British and continental manufacturers to consider seriously the probable effects on their trade and on commercial affairs in the east generally. It has also given an impetus in the same direction to China, and has raised the question whether Japanese or European influence is to dominate the Chinese industrial development. It has given Japan possession of the island of Formosa, which is not only very valuable on account of its mineral and other resources, but is also most important as a naval station. It has, on this account, afforded to Russia an opportunity of pressing her claims for recognition as an eastern

power, probably, however, somewhat prematurely, and before she is prepared to take steps to enforce them. When, however, she has completed the Trans-Siberian Railway to Vladivostock, we may rest assured that she will not make that the terminus. The recent report that she had obtained permission from China to run a branch of that railway down the Liao-Tung province to Port Arthur, and, further, to station a part of her Pacific fleet in the best harbor on the east coast of Asia, at least indicated the direction of an advance which is certain to be attempted sooner or later, and which from Russia's point of view is, on the whole, to be justified. At any rate, we should have little difficulty in justifying it, if Britain were in her place. If this were carried out, and she were allied with France, and, as was recently the case with Germany, as a friendly neutral, the political position would become extremely serious for Britain, for it would change the whole balance of power in the Far West."

That these reflections are not without a solid foundation is proved by a summary of Japanese progress and the influence upon eastern politics it has already exerted. The pace which has been thus set is so rapid that even the present generation may possibly see the awakening of the Chinese nation from the superstitions that have bound her for centuries.

Bimetallism.

THE able manner in which questions of industrial sociology are discussed in the editorial columns of technical journals has been more than once alluded to in the columns of this department. As an example of clearness in thought, comprehensive grasp of a much-debated question, and a talent for seizing upon and exposing the weak point in a plausible fallacy in few words, an argument against bimetallism in a speech made by the chancellor of the exchequer in the British house of commons during a recent debate is conspicuous, as may be gathered from an excellent editorial review of it in the *Journal of Gas Lighting* (March 24). An abstract of this review will suffice to show the skill with which the weakness of bimetallism is exposed.

The "gentlemen of England, who live at home at ease," have no conception of what it means to have to measure every commodity by a shifting standard of value. Yet this is precisely the problem which underlies all commercial questions over a wide area of the earth's surface. Apparently, it is also a condition of existence that a number of worthy and otherwise sane inhabitants of the British Isles wish to import for home experience. What else does bimetallism mean?

"Plain men may be pardoned for experiencing difficulty in understanding how a measure of exchange, or a system of currency, can have any connection with the intrinsic value of commodities. One would naturally suppose the operation of supply and demand competent to fix the value of anything marketable, whatever the nature of the medium in terms of which this value may be expressed. Thus a man gives so much labor in exchange for the price of a sheep. Originally, perhaps, the actual labor was recompensed by the actual animal; but the world has long since found it more convenient to interpose, in the course of all such bargains, a common standard of value, which is called 'money.' How anything in the money itself is to compel a man to work harder for his sheep, or to supply him with the sheep as a reward for a lessened amount of toil, does not appear in the nature of these things.

"The bimetallists seem to hold that there is something in money, apart from its exchangeable value. They appear to hold that, when money changes hands, it also, in some way, changes in value; and they declare that gold, for instance, has 'appreciated' in value, because more can be bought with it than was formerly the case. This argument, as the chancellor of the exchequer justly observed, would be at least intelligible, if it were borne out by facts. If a sovereign would buy more of everything now than it did (say) twenty years ago, one might see that it had attained a higher value; in other words, that it had appreciated. The fact, however, is altogether different. While some com-

modities, such as wheat, wool, and meat, are cheaper as measured by the gold standard, many other things, such as good investments, are considerably dearer. If a man goes into the market to buy a perpetual income of a pound a year, he is bent upon a commercial transaction as fully as when he sets out to buy a loaf of bread. Yet whereas in the one case he can get cheaper bread, or more bread for a stated amount of money, than was ever before obtainable since bread was first sold in the market-place, he must in the other case pay a higher rate for his fixed income than has ever been found necessary in the history of the world's finance. What, therefore, becomes of 'appreciation of gold' between these examples? It simply does not exist, save as a mischievous phantasy.

"The truth of the matter is that civilized and educated men are still as little prepared by their ordinary training as the untutored savage to perceive the operation of natural forces in the concrete effects that strike their consciousness. The world has been at peace, more or less, for a quarter of a century; and during this time means of cultivation, manufacture, carriage, and distribution of the necessaries of life have been more developed, and pushed farther than ever before, in different parts of the world. The average man knows this, in a vague sort of way, as he knows most things that do not very closely concern himself. But, when he sees an actual effect of these and other deep-seated, wide-spreading influences, he does not at first recognize it for what it is. Sometimes he is driven to fall back upon the supposition that it is the nature of the coinage he spends upon his purchases which affects their value. Just as well might the agriculturist regard the material of which his implements of husbandry are made as competent to affect the prospects of the harvest. Meanwhile, the average man of business will probably continue to act as though his first duty consisted in getting possession of as many sovereigns as possible, leaving it to subsequent inquiry to ascertain how to test them for appreciation or the reverse."

Statistics of Labor and Cost of Living.

MR. CARROLL D. WRIGHT, United States commissioner of labor, in a recent lecture at the School of Social Economics in New York, criticised the method of compiling statistics of wages and cost of living that up to a recent period has prevailed in British, continental, and American statistical work. The methods are shown to be crude and unscientific; from such methods only inaccurate and misleading results have been obtained.

The *Scientific American Supplement* (March 28) quotes liberally from this lecture, and presents its most important features. The reports of the British board of trade for the period of fifty years anterior to 1860 are declared to be no better than those compiled centuries ago. The attempt to show the number of persons receiving a particular wage, or a given rate, is of recent date.

Mr. Wright holds that the average earnings of workers in the mechanical and manufacturing industries of the United States, as presented in censuses of 1850–60–70–80–90,—obtained by dividing the total amount of wages by the total amount of wage-earners,—is of but limited value. The mere statement of an average is not sufficient. The mere statement of highest and lowest wages with an average is not sufficient.

"The scientific method requires to know how many persons in a given occupation are in receipt of wages above, and how many below, a given average." Averaging wages by adding together the highest and lowest wages paid in an establishment, and dividing the sum by two, as has often been done, is a vicious method, and seldom, if ever, gives a true average.

Inherent difficulties in the collection of original data, resulting from peculiar conditions, are exemplified as follows:

"A man will sometimes work at more than one occupation during a given period. Cases, indeed, often occur where a man will be engaged in several different occupations within a year. Even if he remain at one occupation, he may be promoted to a higher rate of pay, each ad-

vancing rate representing higher skill or larger industry and attention. Piece-workers are also the cause of many of the complications in wage statistics. The pay-rolls of works will often show only the amounts paid the workmen, no record being made of the time or of the number of pieces of work which the pay represents. The lecturer instanced the case of a coal mine, where the books must show only the successive dates at which the tons of coal mined were credited to the workmen. The miner may have worked all or only part of the time included between these dates. The output with which he is credited may represent his own labor only, or that of himself and his own half-grown son or other helper. It will be thus readily seen that it is at all times difficult, and often impossible, to ascertain the time of a piece-worker; and yet the time is an absolutely essential element in determining wages. A further difficulty is found in the fact that certain important employees work in gangs, crews, turns, shops, etc., different industries having different terms. The method of payment in such cases is liable to be as various as the terms themselves, and it is not universally the same in any given industry.

"Mr. Wright drew a distinction between nominal wages and real wages. Nominal wages are the actual cash payments made to employees, and, in considering their amount, no account is taken of the purchasing power of money. Real wages can be determined only by ascertaining the price of articles, or the purchasing power of the employee's wage. This is best done by taking the prices of articles entering into an individual's consumption at certain specified periods, and calculating how much a given amount of money will purchase at these periods. Mr. Wright considered that this method was a simpler, more common-sense, and less theoretical method than the European, with all its complication of piece statistics, weights, index numbers, etc. What one dollar will buy in flour or in any other commodity at different periods tests the question of real wages in a simple and effective manner."

Regarding the value of statistical work, the speaker said that "it is, or should be made, a part of the educational force of the country. A knowledge of statistics and how to handle them in a scientific sense is an essential aid to proficiency in medicine, law, journalism, and, above all, in politics."

Those interested in statistical studies will find this article a profitable study. All statistics should be carefully examined before they are accepted.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*5262. The Present Value and Purchasing Power of Gold. H. M. Chance (Showing that the value of metals depends on the cost of production, and that, in accordance with this law, the inertia and tradition which now maintain the value of gold must sooner or later yield before the increasing volume due to decreasing cost of producing gold by underground mining). Eng Mag–May. 3300 w.

†5274. Industrial Communities. W. F. Willoughby (This article is the first of a series upon this subject to be published in successive numbers of the Bulletin. Each article will be complete in itself, giving the results of the investigation as to one or more communities. The investigation was made by the author during personal visits to the several communities dealt with. The information in this first part relates to the employees of the coal mining company of Anzin, and is presented in such a way as to furnish opportunity for statistical comparison of present and former conditions of men, the general and physical conditions of whose labor have remained practically identical, and the conclusion is that there has been a steady betterment of their condition in almost every particular). Bul of Dept of Labor–March. 15000 w.

†5275. Recent Reports of State Bureaus of Labor Statistics (Summaries: Connecticut, eleventh annual report, 1895; Iowa, sixth biennial report, 1894-95; Montana, second annual report, 1894; Nebraska, fourth biennial report, 1893-4; New York, twelfth annual report, 1894; North Carolina, eighth annual report, 1894; North Dakota, third biennial report, ending June 30, 1894; Pennsylvania, annual report, Vol. XXII, 1894; Rhode Island, eighth annual report, 1895; Tennessee, fourth annual report, 1895, and West Virginia, report for 1893-4). Bul of Dept of Labor–March. 5400 w.

We supply copies of these articles. See introductory.

†5276. Ninth Report of the Annual Statistics of Manufactures in Massachusetts (Summary and abstract). Bul of Dept of Labor–March. 1000 w.

†5280. American Trade with Spain and Spanish America (A consideration and discussion of the best means for facilitating commerce between the United States and Spain and Spanish dependencies). Consular Reports–March. 4000 w.

†5281. Spanish Industries (Enumeration and some statistics of the principal industries carried on in Spain). Consular Reports–March. 3000 w.

*5296. Industrial Problems in the Far East (Editorial dealing principally with these problems as related to the Chinese and Japanese empires, which are considered not only as important to the politicians and manufacturers of other nations, but as affording a most interesting field of study for sociologists). Engng–April 3. 2000 w.

*5319. The Investor's Dilemma—A "Boom" in Credit (The fact that we are passing through the longest spell of the easiest money ever known, resulting in what the writer calls 'a boom in credit' is stated and effort is made to explain this anomalous financial situation, by the comparative lack of adequate outlets for money, the heavy fall in prices of commodities, and the financial unrest in America). Banker's Mag, Eng–April. 5000 w.

*5320. United States Loans: Their Peculiar History. Alexander D. Noyes (The success of the late United States loan is regarded as a result of luck, while shortcomings and blunders in the details of the negotiation are charged. The financial administration of Mr. Carlisle is severely criticised. His attitude toward Wall St. is characterized as childish, but it is admitted that the attitude of the partisan press has made Mr. Carlisle's administration particularly difficult). Banker's Mag, Eng–April. 2000 w.

5322. "Invention"—The Indefinable Requirement of the Patent Law. W. H. Smyth (The first part is an exceedingly able argument sustaining the thesis that the word "invention" as used in patent laws, is indefinable, that until recently it has been a dead letter, and that in its modern use it is a metaphysical myth). Min & Sci Pr–April 4. Serial. 1st part. 1600 w.

5327. The Choice of Location for Manufacturing Plants (Editorial in which the success of a manufacturing industry is considered as depending upon abundant capital, good location, the most modern machinery, and good management. The article is mainly devoted to the topic named in the title and closes with a tabulated statement of the location of the principal manufacturing industries in the United States). Eng News–April 9. 4000 w.

†5333. Is Poverty Diminishing? J. A. Hobson (The estimate of either wealth or poverty, in this paper, is made upon the basis of the quantity of marketable goods represented by income. The statistics of pauperism, showing a reduction in the number of English paupers, are not thought to be evidence of diminishing poverty, this apparent diminution resulting from administrative changes made by boards of guardians. Reports of the labor commission are held to be defective in their methods of making averages, etc. The conclusion is that while poverty, as measured by income, is apparently decreasing, as measured by the quantity of marketable goods represented by income it is not diminishing; while subjective, or felt poverty is growing with the widening gap between legitimate human desires and present possibilities of attainment). Contemporary Rev–April. 6800 w.

†5359. Cardinal Manning—A reminiscence. Sidney Buxton (Details particulars of the great influence of the famous cardinal upon social and labor questions, in particular recounting recollections of his attitude in the great dock strike, and his position as an exponent of new ideas). Fortnightly Rev–April. 9000 w.

*5476. Wages in the Engineering Trade. J. Stafford Ransome (The investigation is chiefly confined to inequalities in different parts of Great Britain, and the reasons for it are sought. The first part deals with reasons popularly assigned but regarded as inadequate). Eng, Lond–April 3. Serial. 1st part. 2000 w.

*5503. The March of Invention (Editorial, the point of which is that inventions which much affect the progress of civilization, require a good deal of time before assuming such a commanding position as to divert the course of national or social life). Engng–April 10. 2800 w.

5525. Use of Credit Instruments in Business (Review of Comptroller Eckels Cincinnati address in which the tendency to the decreased employment of metal money is shown to be dependent upon, and strictly related to improved methods of banking exchanges, which are constantly lessening the necessity of using a metal money; and in which it is asserted that the clamor raised about the lack of money for ultimate redemption is more for purposes of confusion than for argument. Investigation has shown that even in retail business three-fifths of the payments are made by credit instruments). Bradstreet's–April 25. 900 w.

*5572. The Paris Exhibition—1900 (Prospects and probable effects upon commerce editorially considered). Mach, Lond–April 15. 1000 w.

*5573. Patent Law Reform (A criticism of present English patent law and a demand for a reform that shall in some measure approximate in liberality, the United States patent laws). Mach, Lond–April 15. 1000 w.

*5575. A New Remedy for an Old Evil. E. J. Smith (The first of a series of articles by the chairman of the Bedstead Makers' Association, with editorial, commenting favorably upon a speech of Mr. Chamberlain, British Colonial Secretary, with reference to the scheme, and appreciative remarks of other public men, and upon Mr. Smith's movement, by which the profits of the Association have not only been increased, but whereby the wages of workmen have been increased 25%, while the product has been much improved in quality). Mach, Lond–April 15. 6200 w.

*5589. Shipping Bounties of Foreign Countries and Their Effect (The instances of successful results are stated to have been few, and a running review of the bounty system, as it has been tried by various European governments, is presented). Engng–April 17. 2500 w.

†5652. United States Trade with Japan (Commercial education in Japan; Japanese manufactures, agricultural and mineral products; wages; foreign vs. Japanese products; Japanese banking and foreign trade; Japanese producing capability; effects of opening up China to trade; imports and exports of Japan; and how to increase American trade in Japan, are topics treated in this report). Consular Reports–May. 3800 w.

†5653. Progress and Present Condition of Japan (Observations upon the army, the marine, railway systems, the schools both public and private, a notable characteristic of the school system being enforced military drill). Consular Reports–May. 1300 w.

†5654. American Manufactures in Japan (An attempt to answer in a comprehensive manner, an inquiry made in department instruction in regard to the prospects of American competition in the Japanese empire. The writer thinks that a mistake is made by the American manufacturer in the attempt to educate the Japanese to our way of doing things, instead of accepting existing conditions, and attempting to supply what the conditions call for, as European competitors are doing). Consular Reports–May. 1000 w.

*5673. Foreign Competition in the Iron Trade. H. M. Punnett (The views of the author are interesting as he is understood to be the mouthpiece of the opinions of the Midland Iron & Steel Wages Board). Eng, Lond–April 17. 4500 w.

†5687. The Argentine Republic: Commerce, Finance, and Industries in 1895 (Copious statistics, covering the entire commerce of the country, with short papers on various branches of commerce and industry, by consuls Baker, Buchanan, and Stephan). Consular Rpts–April. 17500 w.

†5688. Shipbuilders' Strike in Belfast (The full account of this noted strike from its commencement, Oct. 11, 1895, to its termination, Jan. 27, 1896. The strike resulted in an advance in wages of about four cents per day of nine hours. Twelve thousand workmen were thrown out of employment in the Belfast district for over four months, at the approach of winter, and many families were reduced to the starvation point). Consular Rpts–April. 3300 w.

*5694. Need of Better Homes for Wage-Earners. Clare de Graffenried (A comparison between the slums of American and foreign cities is made which is unfavorable to the former. The big tenement house is more used in American cities than abroad, and is regarded as a menance to the moral, mental and physical health of the urban poor. The condition of the poor in the chief American cities is reviewed. It is insisted upon that it would not only pay financially to provide better homes for the poor, but that it would tend to elevation of character among them, and its influence would be adverse to strikes. Many excellent points and suggestions are made). Forum–May. 4400 w.

*5695. Cultivation of Vacant City Lots. Michael A. Mikkelsen (Account of the system adopted by Mayor Pingree of Detroit, followed by a discussion favorable to the advantages and practicability of this mode of helping the poor of our large cities). Forum–May. 2000 w.

*5696. The Unaided Solution of the Southern Race Problem. A. S. Van de Graaff (The presence of an undue proportion of negroes in the southern states is the condition that gives rise to this race problem, according to the views of the author. The general problem resolves itself into the questions:—Is the presence of the negro in relatively excessive numbers to differentiate the South from the North? Is the South, or any portion of it to be dominated industrially, socially, or politically by the negro? Are there to be in the South race wars, race riots, or other forms of lawless aggression by one race upon the other? These questions are discussed at length). Forum–May. 8000 w.

*5698. Bank Monopoly—Specie Contraction—Bond Inflation. Albert Roberts (In this article the national bank system is characterized as the most brilliant and audacious scheme of usury ever devised in the cunning brains of far-seeing financiers. The article is an argument in opposition to this system. The further issue of bonds is deprecated. The writer thinks that bond issues are the root of present financial evils). Arena–May. 3300 w.

*5700. The Industries of Valparaiso (Abstract of an article in the *Chilian Times*. Statistical in character). Bd of Tr Jour–April. 900 w.

*5701. Tariff Changes and Customs Regulations (Includes Sweden, Netherlands, France, Algeria, Portugal, Spain, Italy, Greece, United States, Brazil, British India, Trinidad and Tobago, and Western Australia). Bd of Tr Jour–April. 6500 w.

†5741. Foreign Trade of Siam (The most extended report yet made upon Siamese commerce, prepared with special reference to the opportunity open to exporters of the United States). Consular Rpts–May. 4000 w.

*5769. England's Return to Protection. George Gunton (Reprinted from the *N. Y. Press*. This article holds that at the end of a fifty years' experiment with free trade, England is now taking steps to return as gracefully as possible to the system of protection, and that this is what intelligent protectionists have predicted would be the final outcome). Gunton's Mag–May. 2400 w.

*5770. Credit Associations in Germany (The growth and prosperity of the two systems of co-operative, or poor people's banks, in Germany, known as the Shulz-Delitsch system, and the Raiffeisen banks, are considered an indication of a tendency backward toward communistic or tribal methods, which, if they contain a better means of giving credit to the poor, will command the closest attention and respect of the economic world). Gunton's Mag–May. 3300 w.

*5771. Our American Proletariat (Its menacing conditions. The position is taken that true reform should begin with effective restriction upon immigration and be followed by state and national legislation tending to raise the standard of living of American laborers). Gunton's Mag–May. 1300 w.

*5772. Political Revolution of the South. Jerome Dowd (In this paper a hopeful view is taken of the future of the South, based upon the literary awakening within the last few years, and the rapid organization of clubs and libraries). Gunton's Mag–May. 2400 w.

*5773. Non-Partisanship a Municipal Necessity. D. H. Bolles (The propositions maintained in this paper are (1) partisan control of municipal administration is hostile to the municipal welfare; (2) the only hope of municipal emancipation lies in the fearless and faithful enforcement of the non-partisan policy. Hence (3) the non-partisan has vindicated his right to a foothold, and to the respectful consideration even of his adversaries). Gunton's Mag–May. 1400 w.

†5778. The Development of the Monetary Problem. Logan G. McPherson (The evolution of money from the earliest times when all trade was in the form of barter, and of banks from simple depositories of commodities, are first considered. The principle that money represents human effort as measured against other effort, is then enunciated, and the tendency of civilization toward the increased use of paper representatives of value is the final topic discussed). Pop Sci M–May. 4000 w.

†5779. Pending Problems for Wage-Earners. A. E. Outerbridge, Jr. (A study of the question of the management of employees from a common-sense, as well as a just and humanitarian point of view, is the purpose of this paper). Pop Sci M–May. 6000 w.

5791. British View of the Tinplate Trade. (Abstract of an article in the *Iron and Steel Trades Journal* (London). The opinion is expressed that the tin plate industry has taken firm root on American soil, and all that can be said or done will not alter the fact. The advantage of cheaper English labor is thought to be fully offset by the more modern American plants and labor saving appliances). Bradstreet's–May 2. 800 w.

5818.—$1. Bryce's "American Commonwealth." E. J. James (A criticism of the book named in which, though its purposes and execution are in general approved, certain alleged inaccuracies are pointed out). An Am Acad–May. 12000 w.

5819.—$1. Political and Municipal Legislation in 1895. E. D. Durand (The more important and generally familiar phases of political and municipal legislation are stated and briefly commented upon. Among these are legislation upon suffrage, ballot reform, voting machines, corrupt practices, nominations, legislature and state officers, county government, general municipal legislation, municipal service reform, local indebtedness, &c.). An Am Acad–May. 4200 w.

†5825. The Agricultural Problem. M. B. Morton (In this paper the agricultural problem is considered the most vital in American politics at the present time, and some striking allegations are made. The American farmer, it is said, earns no more than a living, and half of what he makes is consumed in taxes, direct and indirect. It is not therefore strange that he is in distress, and is willing to try almost anything for relief). N Amer Rev–May. 1000 w.

*5826. National Currency and Hard Times. H. H. Trimble (Answers negatively the questions (1) Did the demonetization of silver cause a scarcity of money? (2) Did it reduce the volume of currency in America? (3) Did it cause the hard times which overtook us in 1893? Assigns as some of the more potent causes (1) Unwise and reckless speculation; (2) the rapid multiplication of labor saving machinery; (3) labor strikes and over-production. Tariff legislation is held not to have been a cause, but it acted to retard recovery). Am Mag of Civ–May. 2500 w.

*5827. A Cabinet Secretary of Labor. Morrison I. Swift (Starts out with the proposition that governments that ignore the labor question cannot stand, and that henceforth the question must be how government hands are to be laid on. A system of government avowal and comprehension of labor, by placing the national department of labor on a par with the leading departments of State, and giving its chief administrative position as a cabinet secretary, is advocated as a step in advance). Am Mag of Civ–May. 3800 w.

*5828. "Are We a Nation of Rascals?" A Rejoinder. Joseph Oker (Reply to an article under this title, by John F. Hume, in the March number of the same magazine, which by charging dishonesty upon congress, seems to be rather an agreement with, than a refutation of Mr. Hume's affirmative). Am Mag of Civ–May. 4000 w.

*5829. The Ethics of the Single Tax. George Bernard (The author admits that if the proposed single tax is not in itself right, it will do a great wrong, and then undertakes to show that it must be right because it conforms to fundamental principles of ethics, and conflicts with no one of the sacred rights of humanity). Am Mag of Civ–May. 3800 w.

*5830. New Commercial Alliances. Julian R. Elkins (The prediction is made that the United States is again to be the commercial mistress of the high seas, and an attempt is made to show that all signs point to the fulfillment of this prophecy. A good deal of rhetoric of the "spread eagle" variety is indulged in). Am Mag of Civ–May. 1700 w.

5858. The Future of Cotton Manufacturing in the South. D. A. Tompkins. Paper read before the annual meeting of the New England Cotton Manufacturers' Association (Reviews the changed conditions since the war, and their effect on manufactures, and considers the subject in relation to raw material, labor, climate, markets and transportation facilities). Mfrs Rec–May 1. 5400 w.

†5917. The Political Darwin. Ariel (A humorous satire upon modern financial bunglers, who are styled "three-inch politicians" and treated as being in the first stages of evolution toward higher development. The folly of attempting to hurry up this development also comes in for an amusing bit of humorous writing). Ind Engng–April 4. 1000 w.

MARINE ENGINEERING

White Metals for Bearing Surfaces.

MR. ROBERT DAVISON, in a paper read before the Bristol Center of the Institute of Marine Engineers, called attention to the trying conditions to which marine engines are subjected, and the importance of attention to frictional bearing surfaces in this class of steam-engine work. We herewith present an abstract of this excellent practical paper, the entire paper being printed in *The Practical Engineer* (April 17).

"White metal has come into very extensive use, and is applied with advantage to nearly all wearing surfaces, particularly crank and main shaft bearings, guides, and valve faces. In some cases, however, such as in cross-head and pump-link brasses, it does not appear to give such satisfactory results. This may possibly be accounted for by the comparatively small amount of movement in the latter cases, and consequent incomplete lubrication. In white-metalling a new bearing, a good plan is to have the bearing cast with longitudinal recesses or channels about ¾ in. apart, and a circumferential recess at each end of the brass of the same depth as the other recesses and into which they lead. The bearing should be well heated, and the white metal poured into the channels so as to fill them and stand 1/32 in. above when finished. It will now be seen that the white metal in the end channels serves to keep the lubricant from running out of the bearing. The bearing is then bored and dressed in the usual way. One of the smoothest bearings I have ever seen was that of a crank shaft fitted with brasses hexagonally shaped on the outsides to fit the ordinary pedestal and cap. These brasses, no doubt, from a point of economy, had been cast with these rectangular holes in the top half brass. I remember having to assist in stripping this shaft, and, on removing the cap, a small quantity of oil was found retained in each of the holes mentioned. This, I think, goes to prove that, when sufficient bearing surface is provided, it is of advantage, when metalling, to keep the recesses closed, by forming the circumferential end channel described above. With old worn bearings, in which the thickness will not permit of recesses being formed, the first step is to have them thoroughly cleaned and tinned. This cannot be done too carefully in order to obtain a satisfactory job. The metal may then be applied in strips, or to the whole surface, if deemed necessary. It is usual to well heat the bearing in all cases when applying the white metal, to avoid the risk of the metal getting loose when cooling. If this is done, and proper precaution is taken in the tinning, I am confident that there is no likelihood of this taking place, and consequently see no necessity for drilling dowel holes, as is sometimes done, with the object of drawing the metals well together. Those who are inclined to be timid in trusting to tinning operations alone may possibly be relieved of their doubts by the following instance. A large wrought-iron half strap for a paddle-wheel was tinned on its inner surface, afterwards laid in loam, and white metal poured from a ladle into the space prepared for it. It was then taken out of the mould and left to cool. When preparing it for machining, the points of the straps were found to have closed towards each other to such an extent that it was necessary to take a cut over the face of the joint to make it straight. This alteration in shape can only be accounted for by the cooling process. The white metal, being so much hotter than the strap, had contracted to a greater extent, and so caused the deflection. This also, I think, goes to show that the tenacity of the white metal to that to which it may be affiliated is very great. With cast-iron blocks it may be prudent to have a shoulder on the sides next the joints to support the white metal, or even to drill dowel

holes. Tunnel bearings, which have not been previously fitted with white metal, can be dealt with in a similar manner to worn brass bearings."

In metalling brass eccentric straps, the thickness and strength at the crown of the strap may be maintained, but the author regards cast-iron as the best material for marine engine eccentric straps, provided ample wearing surfaces are supplied. For guides white metal is also good, but oil channels should be formed in the faces. White metal is recommended for slide valves. It should be inserted in holes in the faces of the valves in such manner that the line of margin of the plugs in one row will overlap the line of margins in the adjacent rows between the plugs in these rows. White metal is also recommended to be put between the sleeves of the tail-shaft, its effect being beneficial in preventing corrosion. For feathering-gear eccentric straps in paddle-wheel engines white metal is preferable to brass for liners. Of course, with the variety of white metals on the market, there is some difference in quality, but the author very properly declined to recommend one more than another, leaving this matter to the judgment of engineers.

Compound Marine Boilers.

In a paper read before the Institution of Naval Architects, reported in *Engineering* (April 3), Colonel N. Soliani, director of naval construction in the Royal Italian Navy, calls attention to the natural reaction in favor of ordinary marine cylindrical boilers, which has followed the "advance of water-tube boilers in the field of steam navigation." The latter are believed by many, although inferior in certain respects, to possess features of great value for marine purposes, not yet fully secured in the new boilers. This view refers, however, to boilers for ships other than torpedo craft, which have requirements that only water-tube boilers can now fulfil. Within these limits the contention in favor of cylindrical boilers does not appear groundless.

In fact, the marine cylindrical boiler is not a new production of the inventive genius of man, but is the result of the experience of two generations at sea. It is the last stage of development and improvement reached, under existing practical conditions, of an "organ" in the evolution of the entire "organism," "the steamship," to which it belongs. And, in so long an adaptation to surrounding conditions, the marine boiler, from the early types to the present one, has, in effect, developed features of real fitness for ocean navigation, and has reached a state of perfection not easy to attain immediately with any new boiler.

The prominent features of the modern marine cylindrical boilers are well known, —*viz.*, efficiency, simplicity of parts, fewness of bolted joints, durability, easiness of inside inspection, fitness to available space on board ships, small liability to derangement, possible concentration of large power in few boilers (so reducing number and complications of pipes and fittings), steadiness of action, by which water feed and steam pressure are under easy control, facility of repair of the heating tubes under steam, adaptability for temporary use of sea-water for supplementary feed, etc.

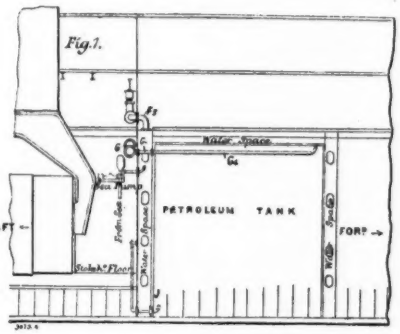
Although some of the foregoing characteristics may be claimed also for water-tube boilers of various types, others are certainly special to the cylindrical boiler, and it is to these important features that cylindrical boilers owe their success in the domain of ocean navigation, and the present campaign in their favor.

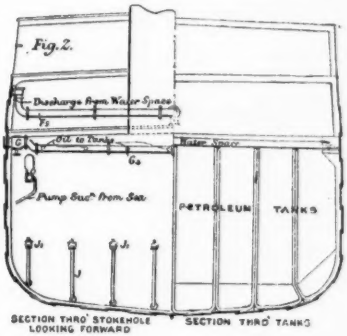
Only in France have water-tube boilers been much used by the mercantile marine. Colonel Soliani does not think the "proclaimed unsuitableness" of cylindrical boilers for forced draught is yet proved to be unavoidably due to the organic constitution of this type, but intimates that this unsuitableness may be due to the magnitude of the extra strain, and the suddenness with which it was applied, before the boilers had had time to adapt themselves to the new demands made upon them. In support of this view, he cites results obtained with Servé tubes and the Howden and Brown systems of combustion; and he adds: "while it is pretty certain that, owing to certain important advantages which

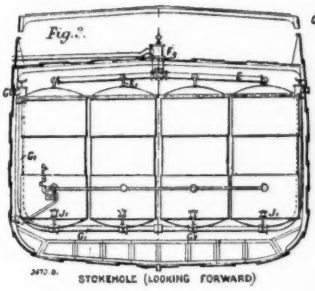
water-tube boilers offer, principally for navy purposes, the difficulties which still beset their general adoption will be vigorously attacked and finally overcome, I think, from what has been said above, that cylindrical boilers not only have, as yet, a great power of endurance in the mercantile competition, but that there is still room on their side for further improvement, by which their vitality may be increased, and

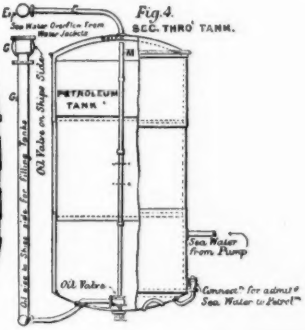
Oil-Tank Steamers.

THE cuts herewith reproduced are from *Engineering* (April 17), and the descriptive matter is an abstract of a communication to that paper by Joshua Phillips. Referring to the ineffectual attempts made to extinguish a fire which recently broke out in the Dutch oil-tank steamer Bremerhaven, and came very near destroying the ship, he says that vain attempts had been









the struggle prolonged, even for navy purposes, with advantage to the great interests involved."

He then proceeds to describe, with illustrations, a suggested improvement in cylindrical boilers, consisting in compounding them with water-tubes, and intended to conserve the valuable characteristics of both systems. This part of his paper is technical, and cannot be here reviewed; but it is suggestive of possibilities of great interest to marine engineers.

made to put out the fire (which started in the fire-room) by means of wet mats and sail-cloths; and that he has found the application of sand to be one of the best means of quenching shallow depths of burning oil; and, in the by-laws which he was recently commissioned to draw up for the importation of crude petroleum in bulk into England, he insisted that there should be a supply of sand on the steamer and landing-places during discharging-operations.

There can be no doubt that, if the cofferdams are kept empty, and periodical observations made for leaks into them from the oil tanks, it would be safer than filling them with water and observing the first indication of leakage in the stokehole. The principal danger from this system would be that, should there be a leak of oil into the empty cofferdam, which would be pumped back into the oil tanks, it would soon contain an explosive mixture of petroleum vapor and air, and great care would have to be exercised to prevent any flame from getting near it. In such case any openings should be carefully covered with wire gauze.

While it is seen that vessels, when loaded with petroleum, are not altogether free from risks of fire and explosion, there can be no doubt that, after being unloaded, the risk from explosion is greatly enhanced.

Wire gauze should play a more important part in the handling of petroleum in bulk than it does. The writer recently superintended the discharge of two tank steamers containing about four thousand tons of crude petroleum (flashing below 60 deg. F.) in the River Tees. The oil was pumped from the steamer into tank lighters holding about two hundred and fifty tons, and then towed up the river to the landing-place, a distance of three miles; the oil was then pumped from the barge into ten-ton railway-tank wagons, nine of which were filled at the same time. All openings or ventilators on the ship, barge, and railway tanks were covered with wire gauze of thirty-six meshes to the lineal inch, and the funnels of the steamers, tugs, and locomotives were covered with spark-arresters. With such precautions the discharge was conducted with perfect safety. This is the first time crude petroleum (flashing below 73 deg. F.) has been imported and so discharged in England, and there can be no doubt that, if the regulations for its safe handling should be rigorously enforced, risks from fire and explosion would be very remote. Coming from an authoritative source, these practical suggestions are worth consideration.

Tests of Boiler Plates.

THE recent change in rules for testing boiler plates, adopted by the board of inspectors of steam vessels, excites much adverse comment. *Engineering News* (April 9) takes up the discussion, and unsparingly criticises the action of the board. It says: "The method of adopting rules for this board seems to be to get the manfacturers of plate to say what specifications they would like to have, and then give them what they ask for. As a consequence, the shape of test piece specified by the rules of the board for testing boiler plates made of iron has been for the past twenty years so bad that it has been condemned by every engineering writer who has had his attention called to it. Up to 1894 these rules applied also to steel, but since that date the shape of test pieces for steel plate has been made different from that for iron plates. In 1894 the tensile test piece for steel was specified to have the straight portion of a length at least eight times the width multiplied by the thickness, and of a width of one inch. Why the standard length of eight inches between gage marks, adopted almost universally by testing engineers both in Europe and in the United States, was not chosen, we cannot imagine. The new rule, which is said to have been adopted after considering the changes urged by representatives of steel-plate manufacturers, specifies the following:

"'The straight part in the center shall be 9 in. in length and 1 in. in width, marked with light prick punch marks at distances 1 in. apart, as shown, spaced so as to give 8 in. in length.

"'The sample must show, when tested, an elongation of at least 25 per cent. in a length of 2 in. for thickness up to ¼ in. inclusive; and in a length of 4 in. for over ¼ to 7-16 in., inclusive; in a length of 8 in. for 7-16 to 1 in., inclusive; and in a length of 6 in. for all thickness over 1 in.

"'The reduction of area shall be the same as called for by the rule of the board. No plate shall contain more than .06 per cent. of phosphorus, and .04 per cent. of sulphur."

"If we correctly understand this rule, the elongation of a specimen of plate 0.24

in. thick would be measured over a gaged length of 2 in., but, if the plate were 0.26 in. thick, it would be measured over 4 in. The allowance of phosphorus up to 0.06 per cent. is extremely liberal to manufacturers, and it would indicate that they had a good deal to do with framing the specification."

Following this criticism, mention is made also of a standard specification, established by steel manufacturers, which is regarded as considerably better than the specifications of the board of inspectors, but open, nevertheless, to just criticism. This specification requires that "the elongation shall be measured on an original length of 8 in., except when the thickness of the finished material is 5-16 in. or less, in which case the elongation shall be measured in a length equal to sixteen times the thickness, and except in rounds of 5-8 in. or less in diameter, in which case the elongation shall be measured in a length equal to eight times the diameter of section tested."

Engineering News calls attention to the fact that, in the application of this specification, "if the test specimen had a thickness of $\frac{5}{16}$ in., or a diameter of $\frac{5}{8}$ in., the elongation would be measured over a length of 5 in., but, if the thickness or diameter were a trifle greater, it would be measured over 8 in. In other ways this specification is objectionable.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

†5258. Free Port of Hamburg (Historical and statistical article, giving voluminous statistics of trade at this port. Also fully dealing with the regulations of trade at the port). Consular Reports–Feb. 27000 w.

†5259. Free Port of Bremen (Complete historical and statistical account with regulations, by-laws, etc). Consular Reports–Feb. 4800 w.

†5260. Free Port of Copenhagen (Circular issued by the Copenhagen Free Port Co. at the opening of the port in Nov., 1894, setting forth its purpose, commercial advantages, accommodations for vessels, regulations, by-laws, schedule of taxes, etc., with supplementary report dealing with the effect of the free port on trade). Consular Reports–Feb. 9400 w.

†5282. The Port of Nantes (General description and statistics). Consular Reports–March. 2500 w.

*5294. Circulation in Water-Tube Boilers. W. H. Watkinson (Paper read before the Inst. of Naval Architects. The main object of this paper was to call attention to a series of models shown in action, and so constructed that the circulation, set up by heat in the furnaces, could be observed. The models included the more important types of this class of boilers, as applied to marine service, and the paper is a valuable contribution to the literature of the subject). Engng–April 3. 3800 w.

*5295. Compound Marine Boilers. N. Soliani (Paper read before the Inst. of Naval Architects. An able argument setting forth the advantages of this type for marine service, more particularly for the merchant marine). Engng–April 3. 1400 w.

5466. Inclined Planes for Boats—Their Early Use and More Recent Examples (Illustrated description of inclined planes used to shift boats in canals, lagoons, etc., from one plane to higher or lower planes. This device, though it preceded locks, is still in use in the Orient). Sci Am Sup–April 18. 3500 w.

5467. Ship Protection by Discrimination (An editorial argument supporting the policy of discrimination and setting forth its effects for the first thirty years after the organization of the United States Government as contrasted with effects of the opposite policy during the three decades ending in 1890). Sea–April 16. 1600 w.

5470. Aluminum in Shipbuilding (Review of a report recently made by M. Guillemoux upon the condition of two aluminum vessels of the French navy, which have been in use two years. The metal was found to have been attacked by salt water where the hull had been imperfectly protected by the paint). Ir Age–April 16. 500 w.

*5478. The Japanese Warship Fuji (Illustrated general description). Eng, Lond–April 3. 700 w.

*5479. The Austrian Torpedo Boat Viper (Illustrated general description which is also made the occasion for a general discussion of the policy of building vessels of the destroyer type. Cuts show arrangement of the Yarrow boilers in Dutch cruisers). Eng, Lond–April 3. 1800 w.

*5504. H. M. S. "Renown" (Editorial discussion of the points in this new ship, which made her full speed contractor's trial trip on April 6, the ship being the prototype of the five new battleships of the 1896 programme). Engng–April 10. 1800 w.

*5505. Microscopic Flaws in Steel. A. E. Seaton (The causes of mysterious fractures in the steel used by marine engineers as revealed by the microscope. Read before the Inst. of Naval Architects). Engng–April 10. 2300 w.

*5506. Some Geometry in Connection with the Stability of Ships. J. Bruhn (Read before the Inst. of Naval Architects. Geometrical principles are regarded in this paper as at the very root and foundation of the question of stability in ships, and the discussion, after a brief review of the methods hitherto used, proceeds on geometrical lines to the construction of a set of cross-curves of stability for inclinations of from 90 to 180 degrees, when the corresponding curves from 0 to 90 degrees inclination are known). Engng-April 10. 4300 w.

*5556. Assistant Engineers in the Royal Navy (Text of the regulations for the guidance of candidates for direct appointments in the Royal British Navy, indicating very clearly the nature of the examinations through which candidates for the post of assistant engineer are required to pass). Eng, Lond-April 10. 8000 w.

*5576. White Metals for Bearing Surfaces. Robert Davison (Extract from paper read before the Bristol Centre of the Institute of Marine Engineers. Deals with the application of these metals to the working parts of marine engines. The higher pressures and speeds now in vogue have greatly increased the use of these metals, and their substitution for brass where the latter has been used in engine construction). Prac Eng-April 17. 1700 w.

*5590. Oil Tank Steamers. H. Joshua Phillips (Fire risks in oil tank steamers and how to lessen them. Best method of extinguishing shallow depths of burning oil). Engng-April 17. 500 w.

*5591. Stresses Due to the Pitching of Ships. A. Kriloff (Paper read before the Institution of Naval Architects. A new theory of the pitching motion of ships on waves and of the stresses produced by this motion. The treatment is mathematical, employing the calculus, and the text is illustrated by diagrams). Engng-April 17. 3000 w.

5635.—$1.50. Some General Notes on Ocean Waves and Wave Force. Theodore Cooper (A learned discussion, illustrated by diagrams, comprising formulæ and examples of wave action and force compiled from a variety of sources). Trans Am Soc of Civ Eng-April. 6000 w.

†5655. Merchant Marine of Japan (Abstract from a series of articles recently published in the *Nichi Nichi Shimbun*, with tabulated statement of vessels and tonnage showing the growth of the Japanese merchant marine during the ten years ending with 1894). Consular Reports-May. 400 w.

5685. Rigs of Sailing Vessels (Description of the various rigs of sailing vessels with 28 diagrams). Sci Am Sup-May 2. 1100 w.

*5699. The Condition of the French Mercantile Marine (Abstract of an article in *Journal des Debats*, upon the present unsatisfactory condition of the French mercantile marine, expressing the fear that it will have ere long, declined into complete ruin in face of the formidable competition which is destroying it. This view is supported by references to statistics of naval construction). Board of Tr Jour-April. 1500 w.

5707. An Open Letter. Alex. R. Smith (This letter is addressed to John R. Bartlett, President of the Nicaragua Company. It urges the alleged fact that the advantages to the industry of marine engineering in the United States, provided it be made an exclusively American enterprise, have been inadequately presented, and that the lukewarmness of the advocates of the canal, is due to this fact. The writer holds that if the canal were constructed on this basis, 500 to 1000 modern ships would be needed, an expenditure of from $100,000,000 to $200,000,000 would be distributed among shipyards employing American labor, and that from 40,000 to 50,000 Americans could be furnished with profitable employment afloat. These statements properly and energetically placed before the American public, would, in the writer's opinion make American labor clamorous for the construction of the canal). Sea-April 30. 1500 w.

5708. Queen of Battleships (The Massachusetts makes a record of 16.15 knots. For six hours she steamed 17.3 knots, which eclipses all records for vessels of her class. A premium of $100,000 earned by her builders). Sea-April 30. 1700 w.

*5797. A Notable Clyde-Built Schooner (Illustrated general description). Eng, Lond-April 24. 900 w.

*5801. Double-Acting Oil Engines for Boat Propulsion (Illustrated general description). Engng-April 24. 500 w.

*5802. Lower Thames Navigation (The imperative nature of improvements in the navigability of the Thames River, made necessary by the modern increase in size of vessels, and the specific improvements needed are discussed editorially). Engng-April 24. 2000 w.

*5805. The Non-Uniform Rolling of Ships. R. E. Froude (Paper read before the Inst. of Naval Archs. Criticism of a paper read by the eminent M. Emile Bertin at a meeting of the Inst. in 1894. The first part regards M. Bertin's system as needlessly retrograde as would be a reversion to bows and arrows from modern rifles). Engng-April 24. Serial. 1st part. 3000 w.

†5824. The Engineer in Naval Warfare. Symposium by George W. Melville, W. S. Aldrich, Ira N. Hollis, Gardiner C. Sims, and George Uhler. The great and increasing importance of the engineer in marine warfare, and the needs of the future are herein set forth). N Amer Rev-May. 21700 w.

†5886. The Western River Steamboat. William H. Bryan (Read before the A. S. M. E. Defense of the present type of western river-steamer as adapted to the commerce it is employed in, and an answer to criticisms that have been made upon them, as not sharing the improvements that have marked our lake marine construction). Trans Am Inst of Mech Engs-Vol. XVII. 1800 w.

5898. United States Revenue Cutter No. 3 (Illustrated detailed description). Am Mach-May 7. 1600 w.

5902. The Speed Trial of the United States Battleship Massachusetts (Illustrated popular description). Sci Am-May 9. 900 w.

MECHANICAL ENGINEERING

The Manufacture of Steam.

IN our December number we presented an account of the organization of the Steam Users' Association under the general supervision of Mr. Edward Atkinson and under the special directorship of Professor Peter Schwamb, of the Massachusetts Institute of Technology. Some results of this effort are now presented by the association in a series of circulars, entitled "*Progress Reports*," from which the general character of the work can be better appreciated than it could from the announcement. Circular No. 3 is a pamphlet of twenty-six pages. It is a preliminary report of a comparison of the efficiency of different fuels, and is submitted to members with the statement that, as there has not yet been sufficient time to complete the record and tabulate collected data, it will be subject to revision.

An introduction by Mr. Atkinson concludes with a request for suggestions for investigation in Great Britain and on the continent, which Mr. Hale, expert of the association, will soon visit. Mr. Atkinson also calls attention to his own experiments in economizing heat for cooking purposes, and propounds the theory that the application of the principle of encasement with a non-heat-conducting material, which he has so successfully used in his well-known cooking apparatus, is the rational way to economy in the manufacture of steam. This is followed by "Progress Report, No. 3." prepared by Professor Schwamb and Mr. Hale, which repeats the explanation that the appended tables are not complete, and that the conclusion derived from them must be, for the present, regarded as provisional only. For this reason we are not permitted to make excerpts from the circular, though there are some passages in it which are of interest, particularly some remarks on the use of culm in a large iron-melting establishment, in which the owner, instead of being obliged to purchase, was paid ten cents per ton for removing the fuel subsequently utilized in his furnace.

Circular No. 4 contains a preliminary report by Mr. Atkinson upon the cost of delivering coal to boilers, and "Progress Report, No. 4." prepared by Professor Schwamb and Mr. Hale. This is a preliminary report on cost of delivery of coal to boilers.

Examinations of plants with coal-handling appliances burning fifty tons per week have disclosed at least one case where the cost of handling reaches ninety cents per ton. It is thought the cost of handling in plants of this capacity ought not to exceed fifty cents per ton. An average labor-cost for hand-fired plants exceeding a weekly consumption of fifty cents per ton is found to be eighty-seven cents per ton. This, it is thought, could also be reduced to fifty cents per ton. The data upon which this report is founded were obtained in response to a circular of inquiry, accompanied by a printed blank form in which answers to special queries could be briefly inserted.

"Circular No. 4" is also accompanied by a blank form prepared by Professor Schwamb and Mr. Hale, designed for data relating to cost of labor in producing steam. Of this form, the authors say that it is the result of their consideration of conditions observed in the inspection of some twenty to thirty establishments. It is admitted that in the inspection some obtainable information may have escaped the notice of the expert, and that mistakes in the record may have been made. Corrections are, therefore, solicited, and suggestions are invited. These investigations, however, indicate that some establishments can probably make a considerable saving in this item,—enough out of the small number so far compiled to more than pay the whole expense of this investigation, if they are thereby brought to the standard indicated by the fairly economical plants.

"Further data are needed on this subject. For instance, we find that in nearly every one of the hard-coal plants of which we have data the amount of coal per man is about the same as in soft-coal plants under corresponding conditions as to load, etc., but the rate of wages is higher, making the cost per ton higher for the hard coal. It is, therefore, impossible as yet to tell whether this is because men have to be paid higher wages to handle hard coal, or whether these men would insist on the same wages and handle no more soft coal than they do hard. The location of the plant does not, so far, appear to explain this difference of wages.

"Several plants running under different conditions, but obtaining about average results, have been selected, and their figures are placed directly opposite the headings as a guide in filling out the columns, and also as examples of what seems to be fair, but not necessarily the best, practice under their conditions.

"Reliable data are especially desired from plants using mechanical stokers, shaking and damping grates, and down-draft furnaces. Records from the same plant in successive years under the same conditions are also desired. In plants where special coal-handling devices are used, data as to cost of installing, repairing, and operating are desired, so that the effect on the cost of firing may be directly studied."

Wax for Holding Work on Grinder.

WHEN we recall that for a long period wax has been used by opticians and lapidaries for firmly holding small pieces to be ground, it seems strange that it should not have sooner and more widely occurred to machinists that this method could be extended to much of the grinding-work now done in machine shops. A correspondent of *American Machinist* (April 30) writes that the method is used with great satisfaction in an establishment requiring the grinding of a quantity of small work on Browne & Sharpe surface grinders. The work in question is all hardened, and, of course, is more or less sprung in the process. In grinding this work true after hardening, the springing of the work again during the grinding is prevented by the use of wax as a holding-cement, by which all points of the piece operated upon are held with equal tension to, and supported with equal rigidity upon, a platen or holder. In clamping work for grinding, it is in many cases impossible to hold pieces without springing,—especially if the piece be

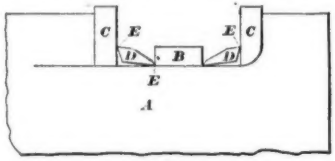


Fig. 1

flat and thin, and must be held by pressure against its edges. More or less buckling is apt to come in in such cases, and, when the piece is ground flat on the holder, it is, when released, no longer flat. With wax used as described, a piece ground flat on the platen is flat when taken off, and, if

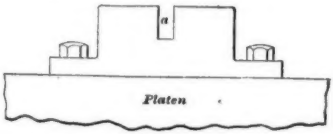


Fig. 2

the opposite sides are required to be parallel, this is probably the very best way in which such a job can be executed.

The correspondent referred to (who signs "Theo") says that, in the factory from which he writes, they "lay the work down on the platen, perfectly free, and then pour hot wax around it. For winter

Fig. 3

we use about three parts of common beeswax to two parts of rosin. It will be necessary to use a slightly greater proportion of rosin for summer. This wax is used almost entirely for grinding parallel work. It holds very firmly, the work rarely, if ever, coming loose; and, as benzine cuts

the wax off from the pieces after they come from the machine, and from the machine platen, it is very little trouble. A pan of benzine is kept at hand to soak the pieces in. The wax will also hold work sufficiently strong on a planing-machine or lathe face plate, if the cuts are light, and it has the advantage of turning out the work as true as the machine itself, and not depending on vises or fixtures which may not be in the best shape.

"Work may be held very well and with good results, as shown in Fig. 1, in which *A* is the vise and *B* the work which is held between the jaws, *C C*, by the strips or ribs, *D D*, bearing at the points, *E E E E*, and tending to hold the work firmly on the base of the vise or fixture. This method has been in use a good many years; but the wax has the advantage of a clear surface over the work, however thin it may be, which prevents any liability of running the tool or emery wheel into the holding device.

"Another very important point is that, when there are a number of pieces to be worked all alike, they may all be put on the platen at the same time, or, at least, it may be covered with the pieces, with only a small space between for wax. It is only necessary to take one off occasionally to caliper, and it may be put back again without trouble. Oftentimes the work is of such nature that it may be put over a T-slot, and so may be measured without removing it from its place. We frequently use a block (Fig. 2) to hold the work, which also admits of measurements without removing the work from its place, the slot, *a*, being large enough to admit the base or anvil of a micrometer caliper.

"I am well aware that the wax method has long been used by instrument-makers on the face plates of small lathes, but think its application to grinding machine is new.

"A convenient thing for holding the wax and melting it is an ordinary pressed-tin cup with a spout put in the side. A piece of cotton string laid in the V of the spout, and hanging outside about ¼ inch, will prevent the wax from running down the outside of the cup, and will enable the operator to direct the drops in exactly the right spot. If the cup is held about three inches above the work, the wax will come up pretty high at the edge where it falls, as shown at Fig. 3, and is best, where the size of the work will admit; but for very thin pieces the cup must be held up twelve or fourteen inches, when the wax will flatten out as it strikes the platen, and will not stand up above the work and have to be pared down, as it would, if the cup were not so held. An ordinary gas jet burning up about ½-inch will keep the wax at about the proper temperature all the time."

We are inclined to believe that this method must have been more widely used than is implied in "Theo's" communication; but the practical hints given upon the mode of applying wax to the purpose of holding small pieces are worth "pushing along."

Insulating Underground Steam Pipes.

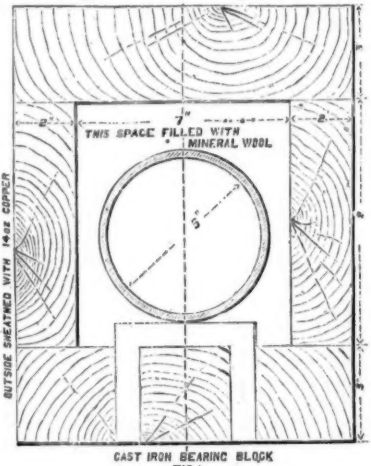
THE insulation of underground steam pipes has always been a matter of difficulty. Many plans have been adopted, a large majority of which have been, to say the least, only moderately successful, while many have totally failed to serve even passably well the purpose intended. If it were possible and practicable to keep the insulating material dry underground, the principal difficulty would be removed. Water infiltrating any porous substance and reaching the surface of a steam pipe insulated by such material destroys its efficiency at once; and practically all good heat-insulating materials are porous. In fact, some eminent authorities have maintained that most of the materials in use for steam-pipe insulation are good for this purpose merely because they inclose a multitude of minute air-spaces, the air confined in these spaces being the effective insulating agent.

The cracking of wood, as ordinarily used for underground pipe insulation, is a serious objection to it.

In *The Engineer* (April 10) Mr. Edgar Kidwell of the Michigan Mining School, Houghton, Mich., presents a method for preventing loss of heat, which seems almost good enough to protect a pipe which

has to pass through a body of water. He states that he has used this method with success under very unfavorable conditions. We herewith reproduce the cuts accompanying Mr. Kidwell's description, which follows:

"To meet these conditions I designed the conduit as in Fig. 1. The lumber was all edged and quite dry. A trough was built in 14-foot sections, with halved joints 1 foot long. To insure rigidity, the bot-



CAST IRON BEARING BLOCK
FIG 1
SECTION THROUGH CASING

tom joints were located 2 feet from those in the side, and all the joints were firmly screwed together, after the conduit was lined up. It has been my experience that, in cases like this, roller-bearings are of little account, since we have no guarantee that they will operate after the pipe has been in use for some time, and the roller journals have become rusted, or stick from the gumming of the oil. I therefore discarded rollers, and placed under each pipe-coupling a cast-iron chair (Fig. 2), which is faced on top, and allows the pipe to slide easily. This plan has been used for years by one concern which employs many hundred feet of 12-inch pipe carrying steam up to 160 pounds, and in no case has trouble developed.

"To insure tightness, the following plan was adopted: makers of planished copper can supply sheets which are slightly defective in the tinning, and have to be sold as scrap. We purchased sheets of this copper, 14-oz. and 16-oz. weights, in widths of 11 inches and 41 inches, riveted and soldered similar widths end to end, then turned up the broad width into a trough 11⅛ inches wide. This was first put into the trench, the wooden trough was then lowered into it, the work was then lined up, the pipe was next laid, and then the trough was filled to the top with mineral wool loosely packed in place. The wooden cover was then secured with 5-inch screws, the 11-inch copper was next rolled along the cover, and the joints along the top edges of conduit were then carefully soldered. The metal covering was carried through the walls of the buildings at each

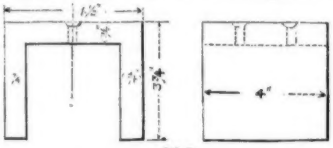


FIG 2
BEARING BLOCK UNDER COUPLINGS
FACED ON TOP

end of the pipe line, and pieces of copper soldered to the casing were flushed into the outside face of the walls.

"To guard against any chance of the pipe getting out of line by reason of decay of the wood, the chairs were provided with two lugs (Fig. 2), which passed clear through the bottom plank and rested directly on the copper, and beneath the latter a large flat stone was carefully bedded into the earth. The chairs were secured to the plank to prevent any motion and the consequent wear on the copper. Where fills were encountered, care was taken to put a bearing stone and cast chair on each side of it, so that any deflection of the conduit could not affect the pipe. The soil was very gravelly, so that no under-drainage was provided, and it is questionable whether such drainage would ever be necessary with a conduit like this. A conduit like this can stand a great deal of distortion without any harm. As to its insulating qualities, I may say that it has been in use several years, has given perfect satisfaction, and at no time is there any external evidence that the pipe line exists. I have never been able to detect

any escape of heat through melting of snow over the trench. Cost of the work was as follows. Cost of pipe and laying mineral wool, and excavating trench are not included, as they form no part of the conduit proper.

Length of conduit..... ....142 ft.

	Dols.
Copper smith, 2¼ days, at 4.00 dols....	9.00
Steam fitter—lining up—1¼ days, at 4.00 dols.....	5.00
Three laborers, 1¼ days, at 1.50 dols....	5.63
Carpenter, 9 days, at 3.00 dols.....	27.00
Solder, copper tacks, and rivets.....	2.20
4 grs. 5 in. No. 20 wood screws...	5.72
1 grs. 2 in. No. 14 " "	.66
1350 ft. white pine at 17 per m.....	22.95
520 lb. tinned copper scrap at .11	57.20
135 lb. castings at .03½.....	4.73
Carting....	1.50
Total..... .....141.59	

Or about 1 dol. per lineal foot. No charges are made for stone-bearing plates or for planing chairs. Lathe work was done in our shops by students. We had left from a new building some stone which we had no other use for, and were glad to get rid of it by putting it under the conduit.

"Mr. Carpenter describes a conduit consisting of a tile pipe placed inside a wooden casing. To me this seems a wholly mistaken construction. As the wood shrinks and swells, it will loosen the joints in the tile. The wood will also absorb water, and be of little use as a heat insulator. It would have been better, I think, to have used a large tile and put the wood casing inside of it. If the tile is properly laid on a sand or gravel foundation and fills are carefully looked after, it can be kept tight, so that the wooden casing will be dry and of some use as a heat insulator.

"The conduit permits the pipe to be got at easily. A few minutes' application of the blast lamp is all that is needed to open up the sheathing, and, as the screws were dipped in lard and plumbago before driving, they can be easily drawn. If no provision is to be made for opening the conduit, it seems to me that the best form of casing is galvanized spiral-riveted or welded pipe, with proper chairs for the steam main to slide on."

Conductivity of Boiler Scale.

THE following is an abstract of an article in *Power* for May. The experiments described were instituted as a result of a statement made by several members at a recent meeting of Columbus Association No. 31 N. A. S. E. of Brooklyn. These engineers said that during their experience they had noticed cases in which boilers were incrusted to a thickness of upwards of one-quarter of an inch, and yet the economy was not affected appreciably. The results of the experiments are thought to prove that the relative conductivities of iron and scale are very improperly applied, when used as a basis upon which boiler economy is reckoned, especially in a properly-designed boiler. In many books on steam engineering can be found statements to the effect that one-sixteenth of an inch of scale will cause a loss of fully fifteen per cent. of fuel, one-eighth will cause a loss of thirty per cent., and that one-fourth will bring the loss up to fifty per cent.

This statement is so broadly made as to justify the inference that the authors mean to imply that the loss will be in the proportions named, in any type of boiler, or in any ratio of grate to surface. Neither is there any exception made regarding the kind of scale, which differs materially in composition in different localities and with the qualities of different feed-waters. The experiments were made with apparatus designed and constructed by the educational committee, Jos. P. Clark, Neil McEwen, and Frank J. Wood, and consisted of the several pieces shown in the drawings.

Fig. 1 is for the purpose of determining the relative conductivity of materials, such as iron, scale, cement, etc., and consists of a small gas stove on which is placed the vessel of water A. After the water is boiling, the cover B, at a signal from a timekeeper, is dropped quickly on the vessel. Through this cover are holes about one inch square, over which are fitted the samples of material to be tested. There

are pieces—one of each—of brass, iron, boiler scale, plaster of Paris, and Portland cement. Stuck with wax to the top of these samples, at an angle of about forty-five degrees, are short pieces of wire. After dropping the cover on the water vessel, the steam heats the samples, and, after the heat penetrates to the wax, the pieces of wire drop. It is obvious that this dropping will be about in the order of the conductivities of the different samples.

Fig. 2 is a cover to be used in the same manner as the one above described, but

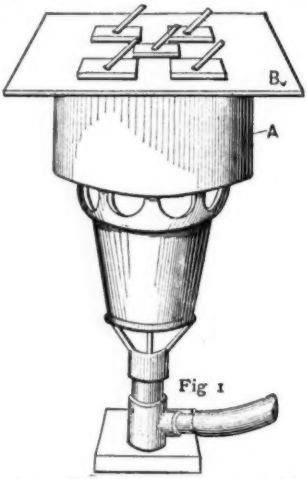


Fig 1

there is a different arrangement of samples. The cover itself is of sheet-brass 1-32 of an inch thick; one square inch of the top is coated over with a sample of plaster of Paris 3-32 thick; another square inch is covered with a 1-4- inch coating of Portland cement. There is a piece of wire stuck

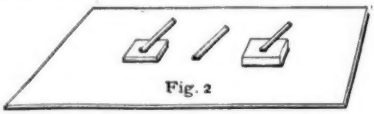


Fig. 2

with wax on the sample of cement, another on the plaster of Paris, and another directly on the brass plate. Figs. 3 and 4 are views of an apparatus for testing the heating efficiency of clean and coated tubes. A small sheet-iron furnace A is heated by a small gas stove or Bunsen burner; on top of the furnace stands the vessel of water B. This vessel is about 1¾ inches in diameter and about 25 inches long. In the interior of this cylinder is a tube extending through the bottom of the cylinder into the top of the furnace and 1-32 of an inch thick and about 5-8 of an inch outside diameter, reaching from about one inch below the bottom end to a little above the top end of the cylinder. The ratio of the diameter to the length of this tube is about the same as that in ordinary boiler tubes.

There were several of these cylinders made; the dimensions and weight of the metallic parts were similar in every respect. Two of these vessels were left clean, but in one there was 3-32 of an inch of plaster of Paris coated on the tube, in the same way in which scale coats a boiler tube; in another vessel 1-4 of an inch of Portland cement was coated on the tube. The tendency of the heated gases from the flame will be to go through the tube in the vessel of water, but, as the capacity of this tube is not great enough to carry off all the gas, some must make its exit by coming down between the outside and inside casings of the furnace and flowing out through the chimney, C.

This chimney carries the surplus of heated products to such a distance from the vessel of water that there is no chance for the outside of the water vessel to act as a heating surface by receiving heat from rising hot gases. In the top of the furnace and directly under the tube is a pyrometer, P, which, though not indicating the degrees, serves to indicate changes in the temperature at the top of the furnace. This pyrometer is made of a small strip of brass riveted to a similar strip of iron, one end being secured to the side of the furnace, while the other is connected by a wire to a pointer that moves over a graduated scale. Unequal expansion of the brass and iron bends the riveted strips, the pointer indicating temperature. In the water at the top of the vessel is placed a thermometer.

In the first experiment (Fig. 1) the water was made to boil briskly, and, at a signal from a timekeeper, the cover was quickly placed on top. The pieces of wire

dropped in the following order: brass, 5 seconds; iron, 9 seconds; plaster of Paris, 35 seconds; Portland cement, 63 seconds; scale (Ridgewood water, Brooklyn), 35 seconds. In the experiment with the cover shown in Fig. 2 the object was to show the relative conductivities of the heating surfaces just as they are in the different water vessels. In this experiment the pieces of wire dropped as follows: brass, 4 seconds; plaster of Paris, 26 seconds; Portland cement, 71 seconds.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

5580. Trolley Systems. H. M. Ramp (The uses and advantages of overhead trolley systems in foundries, and the economy of labor and time effected by them). Foundry–April. 2500 w.

5583. Plumbago Facing. John A. Walker (Reasons why plumbago makes the best facing for sand molds, are found in the physical character of this form of carbon). Foundry–April. 600 w.

5584. Does the Blast Meter Tell the Truth? H. Hansen (Reasons why a speed indicator may probably furnish more reliable indications with reference to a blast for a cupola, than a blast meter). Foundry–April. 1200 w.

5585. Management of Cupolas. E. Grindrod (Holds that there is no chance work in casting when a cupola is properly charged, and gives practical directions for proper charging). Foundry–April. 700 w.

5690. Bed and Cylinder Tools—"Straight Line" Engine Shop, Syracuse. Herman Landro (Illustrated description both of shop and tools employed in the manufacture of the "straight line" engine). Am Mach–April 30. 2000 w.

5692. Wax for Holding Work on Grinder—A Milling Machine Difficulty. Theo (This paper illustrates and describes some very useful shop "wrinkles"). Am Mach–April 30. 700 w.

5756. Laying Out Belting. Thomas Hawley (To drive shafting in various positions. Illustrated description of the various ways in which belting is applied in use and methods of laying out work in their application are presented). Bos Jour of Com–May 2. 2200 w.

5760. Pattern for Gusset Sheet for Locomotive Jacket (Answer to correspondent giving full explanation of method). Met Work–May 2. 1000 w.

5897. Power Required for Driving a Pipe-Threading Machine, a Boring Bar and a Roll-Turning Lathe. J. S. Cox (A record of tests of pipe threading machines made to ascertain the power required for cutting off, and for cutting threads on different sizes of pipes). Am Mach–May 7. 250 w.

Steam Engineering.

*5268. Points in the Selection of Steam Engines. W. H. Wakeman (Showing the factors that enter into a steam engine's usefulness, and the considerations that should govern purchasers). Eng Mag–May. 3900 w.

5364. Efficiencies of Boilers. John C. McMynn (In this paper the author strenuously urges distinctions between efficiency of a boiler, efficiency of a furnace, and efficiency of boiler and furnace considered together, and holds that the separation of the efficiency of furnace, apart from that of the boiler, is a problem demanding solution. He makes however no attempt to solve it). Elec Engng–April. 1300 w.

5480. Economical Equipment and Operating of Power House. H. S. Newton (Paper read before the New York State Railway Assn. Contains valuable suggestions for stationary engineers). Lord's Mag–April. 1800 w.

*5561. Measurement of Feed and Circulating Water, etc., by Chemical Means. C. E. Stromeyer (An ingenious application of the known solubilities of substances in water, to boiler feed measurement, and to the determination of the quantity of water entrained in steam. Read at the 37th Session of the Inst. of Naval Archs.) Eng, Lond–April 10. 3500 w.

5625. A Fly Wheel Built of Steel Plates (Illustrated detailed description. The fly-wheel is also designed for a belt wheel). Eng News–April 23. 400 w.

5693. Triple-Expansion Engine for Direct Connected Electric Generator (Illustrated description with full details of an entirely new valve motion called "pouse-gear," a most ingenious device, with which the intermediate pressure valves are fitted). Am Mach–April 30. 2300 w.

5724. How to Find the Point of Cut-off (Mathematical and graphic methods both given, and the superiority of the graphic demonstrated). Power–May. 900 w.

5725. The Conductivity of Boiler Scale (Experimental determinations with different materials by Jos. P. Clark, Neil McEwen, and Frank J. Wood, of Columbus Assn., No. 31, N. A. S. E. of Brooklyn, N. Y., with illustrated description of apparatus and methods). Power–May. 1500 w.

*5728. The Relative Importance of the Wastes in a Steam Engine. Arthur L. Rice (Computations undertaken in an investigation of the subject of initial condensation from standpoints of both theory and experiment). Sib Jour of Engng–April. 2200 w.

5775. Efficiency of Boilers and Engines. Thomas F. Scheffler, Jr. (Regarding the time as not far distant when the efficiency of boilers will be calculated from the total number of British

thermal units, the author proceeds to discuss a method of determining boiler efficiency on this basis). Mach–May. Serial. 1st part. 1800 w.

*5800. Phillips Water-Tube Boiler (Illustrated detailed description). Engng–April 24. 450 w.

5847. Nova Scotia Coals as Steam Producers. F. H. Mason and W. G. Matheson (The object of the paper is to place on record some results obtained from an analysis of samples of coal from the various mines in Nova Scotia. This is entirely as regards coal as fuel as being capable of evolving so much heat. With its properties as a gas producer, or its value for coking it has nothing to say). Can Min Rev–April. 2200 w.

5872. The Evolution of the "High-Speed" Engine. R. H. Thurston (A comparison of low, moderate and high-speed engines, a statement of the advantages and disadvantages, with copious tabulated data and diagrams. Concludes with an illustrated description of a high-speed quadruple-expansion engine, designed by Messrs. Hall and Treat at Sibley College, and tested in the shops of the institution, which the author states, gives a horse-power with a consumption of less than ten pounds of steam). Elec–May 6. 5400 w.

†5874. Determining Moisture in Coal. B. S. Hale (Read before the A. S. M. E. An account of work done for the Steam Users' Assn. of Boston, and of methods employed in the quantitative determination of moisture in coal). Trans Am Inst of Mech Engs–Vol XVII. 3000 w.

†5876. The Effect, upon the Diagrams, of Long Pipe-Connections for Steam-Engine Indicators. W. F. M. Goss (Read before the A. S. M. E. An experimental investigation of this subject is given with illustrated description of means and methods employed, steam indicator diagrams showing effect of connections and conclusions). Trans Am Inst of Mech Engs–Vol XVII. 3300 w.

†5877. Experiments with Automatic Mechanical Stokers. J. M. Whitham (Read before A. S. M. E. Mechanical stoking and stokers are discussed and their advantages stated, and experimental data, from tests of several kinds, are tabulated). Trans Am Inst of Mech Engs–Vol XVII. 3800 w.

†5878. New Form of Steam Calorimeter. R. C. Carpenter (Read before the A. S. M. E. Illustrated detailed description of a calorimeter in use in Sibley College, for about one year, and of the proper method of using it). Trans Am Inst of Mech Engs–Vol XVII. 1800 w.

†5880. Test of a Four-Cylinder Triple-Expansion Engine and Boilers. A. H. Eldredge (Read before the A. S. M. E. Illustrations of plant indicator diagrams and very full data are presented, the latter in tabulated form). Trans Am Inst Mech Engs–Vol XVII. 1400 w.

†5881. The Effect of Retarders in Fire Tubes of Steam Boilers. Jay M. Whitham (Read before the A. S. M. E. Data obtained from tests of a 100 horse-power tubular boiler, with conclusions favorable to the use of retarders, especially in tubular marine boilers). Trans Am Inst of Mech Engs–Vol XVII. 1300 w.

†5882. A Self-Cooling Condenser. Louis R. Alberger (Read before the A. S. M. E. Describes and illustrates a practical condensing apparatus for use with steam engines, operating without natural water supply and giving results claimed to compare most favorably with those obtained by ordinary condensers). Trans Am Inst of Mech Engs–Vol XVII. 4800 w.

†5883. Superheated Steam. R. H. Thurston (Read before the A. S. M. E. Facts, data, and principles relating to the problem. The subject is broadly treated in all its aspects, with formulæ and diagrams, and illustrations of some forms of superheaters). Trans Am Inst of Mech Engs–Vol XVII. 22000 w.

†5589. The Efficiency of a Steam Boiler. What Is It? William Kent (Read before the A. S. M. E. A defense of the desirability of still using the "pound of combustible" as a basis for the estimation of boiler efficiency, in comparison of different tests). Trans Am Inst of Mech Engs–Vol XVII. 3800 w.

5900. The Action of Fluorides on Feed Water and Corrosion in Steam Boilers. A. Wangemann (A paper read before Robt. Fulton Assn. of stationary engineers. The use of sodium fluoride has hitherto been obstructed by its cost. The writer states that the price has now been reduced and that it is available. Its advantages and practical points in use for preventing scale in boilers, form a very useful paper). Sta Eng–May. 4000 w.

Miscellany.

*5289. The Mechanical Transmission of Power. W. E. Buck (Contains little that is new. The first part is a fairly good review of general practice, so far as possible to carry the discussion. Other succeeding parts will doubtless cover the remaining ground). Mech Wld–April 3. Serial. 1st part. 2400 w.

5326. New Rules for Testing Boiler Plates (A sharp editorial criticism of the new rules of the Board of Inspectors of Steam Vessels so far as they relate to testing plates for use in steam boilers). Eng News–April 9. 1100 w.

5330. The New Rolling Mill of the Pittsburgh Reduction Co., New Kensington, Pa. (Description of a 2-high rolling mill for manufacturing aluminum plates). Eng News–April 9. 1100 w.

5356. Proposed Patent Legislation (Editorial review of bill No. 3014, in the House of Representatives comprising amendments of the present U. S. patent laws). Sci Am–April 18. 1500 w.

5360. Licensing Engineers. W. H. Wakeman (An argument in favor of licensing engineers to operate steam plants, which however admits that there are some good grounds for opposing the system). Safety V–April. 3000 w.

*5399. A New Transmission Dynamometer. S. W. Robinson (Illustrated detailed description with explanation of its application and method of showing corrected results). Digest of Phys Tests–April. 2800 w.

†5409. Circular Wheel-Teeth. Archibald Sharp (The treatment is severely mathematical. The author, having previously described a

method of drawing circular wheel-teeth having a very small variation in their angular velocity-ratio, investigates the problem in a more general manner in this series of articles). Ind & East Eng–March 21. Serial. 1st part. 3000 w.

*5414. The Development of the Milling Machine. Samuel Dixon (Paper read before the Manchester Association of Engineers. Treats of the principles underlying construction, adaptations to different kinds of work, general usefulness, and the rapid increase of its use in modern shops). Col Guard–April 2. 3000 w.

5472. A Simple Derivation of the Formula for the Strength of Beams. Walter Ferris (A very successful attempt to explain the derivation of the formula, without the use of calculus, which explanation, though somewhat more cumbrous than is given by the calculus, is yet quite easily followed by those who can handle simple algebraic equations of the first degree). Am Mach–April 16. 1500 w.

5473. Test of a Compound Air Compressor (Gives data and a computation of saving effected, with some general remarks upon stage compression, as compared with single compression. Review of a graduate thesis prepared by F. C. Weber and W. K. Lanman, at Cornell University). Am Mach–April 16. 1000 w.

5474. A Compressed Air Paradox. Frank Richards (Effect of velocity upon friction of air in pipes is well discussed and a formula for computing the head for forcing air through pipes at different velocities is given). Am Mach–April 16. 900 w.

5489. High-Pressure Air Compressors of the Pneumatic Gun Battery at Fort Winfield Scott, San Francisco, Cal. B. C. Batcheller (Illustrated description with data. An instructive article). Am Mach–April 23. 1800 w.

5490. Uses and Advantages of a Public Supply of Compressed Air for Elevators. Frank Richards (The use of compressed air for elevators in buildings, with diagrams of pressure in air cylinders of stage compression machines, and a statement of conditions under which it may be substituted for the hydraulic system are the main features). Am Mach–April 23. 1100 w.

5577. Iron Foundry Buildings. O. Benson (Construction of roofs with reference to the use of powerful cranes, and of foundries, with reference to reducing fire risks, and cost of insurance, etc). Foundry–April. 1200 w.

5578. The Growth of Foundry Literature. Thomas D. West (Mr. West takes a leaf from his personal experience as a writer for technical papers, and reviews the general effect of foundry literature upon the art of founding). Foundry–April. 2000 w.

5579. Money Saving Devices in the Foundry. E. H. Putnam (Describes a sweep and its use in making a mold of a form illustrated. The sweep is also illustrated). Foundry–April. 650 w.

5581. Impressions Upon Cast Iron Surfaces From Lace, Embroideries, Fern Leaves, Etc. W. J. Keep (Gives full description of the way these impressions may be produced, and illustrates in half-tone engravings the effects so obtained). Foundry–April. 1600 w.

5582. The Effect of Atmospheric Temperature and Humidity on Melting Iron in a Cupola. A. Sorge, Jr. (Maintains that atmospheric humidity is an important factor in melting iron and pouring it into molds, and explains how adverse effects are produced by it). Foundry–April. 600 w.

5624. A New Dynamometer for Measuring Power Absorbed in Driving Machinery (Illustrated detailed description of a transmission dynamometer, claiming to be an improvement on an instrument built by Prof. S. W. Robinson of the Ohio State University for use in the mechanical laboratory of that institution). Eng News–April 23. 700 w.

*5664. The Economical Use of Blast-Furnace Gases. A. S. Keith (Abstract of paper read at the Cleveland Institution of Engineers, England, with short discussion). Ir & Coal Trs Rev–April 17. 2500 w.

*5667. On the Development of the Milling Machine for Heavy Engineering Work. Samuel Dixon (The object is to review in some measure the rapid development of milling which has taken place in recent years in all the best engineering workshops, and to point out the broad lines upon which the development is taking place). Ind & Ir–April 17. 5800 w.

*5671. "The Engineer" 1100 Guinea Road-Carriage Competition (The full conditions of this competition are given, with classification, names of judges, and directions for those who desire to compete, and blank form of agreement, to which competitors must subscribe. The Crystal Palace will be the center from which vehicles will start, which affords facilities for minor trials, and all the publicity which can be desired. The conditions however are only to be valid in case the new act of parliament, now introduced, removes some existing restrictions. The date of the competition is not yet named). Eng, Lond–April 17. 3000 w.

5678. The Kitson Gas Producer (Illustrated detailed description with favorable report of engineer John E. Fry, of Pittsburg, upon the merits of the invention. In this gas-producer the fuel is kept constantly agitated, which agitation is claimed to prevent caking, clinkering and scaffolding of the fuel in the furnace). Ir Age–April 30. 2400 w.

5679. Automatic Feed Device for Gas Producers. C. W. Bildt (Translation from *Jerukontoret's Annaler*, illustrating and describing a new device constructed for the Stridsberg & Bjocrks Works at Trollhattan, Sweden). Ir Age–April 30. 1800 w.

*5726. The Engineering Experiment Station of Sibley College, at Cornell University. R. H. Thurston (Description of the organization of this experiment station, the work carried on therein, its outfit and methods, closing with a plea for further means to extend its usefulness). Sib Jour of Engng–April. 7500 w.

*5729. Carpenter's Viscosimeter. O. Shautz (Illustrated description of a new instrument for testing the "viscosity" of lubricants). Sib Jour of Engng–April. 700 w.

†5738. Some Fuel Problems. Joseph D. Weeks (The Fuel Problem is to reduce the waste and increase the efficiency of the coal we possess. The question is considered under the divisions of (1) the mining of coal and its preparation for market; (2) the use of coal; (3) the products of the coal other than heat). Trans Am Inst of Min Eng–April. 4500 w.

†5740. Notes on Conveying-Belts and Their Use. Thomas Robins, Jr. (Experiments and tests of rubber belting to ascertain what particular compound of rubber would make the most durable carrying-surface. Also, illustrated description of methods of supporting conveying belts, study of proper width for duty to be performed, etc). Trans Am Inst of Min Eng–April. 4000 w.

†5743. On the Determination of the Division Errors of a Straight Scale. Harold Jacoby (Gill's method, an improvement on Hansen's and Lorentzen's formula are both explained and discussed. A modification of Gill's method, by the author, follows, whereby accuracy within $\frac{1}{50000}$ inch is obtained, and the non-periodic errors of a screw are determined without assumption of any law of error). Am Jour of Sci–May. 3400 w.

5774. Magnesium as a Constructive Material. R. H. Thurston (The author regards magnesium as a possible rival of aluminum in alloys for use in the arts, and gives reasons for this opinion). Mach–May. 2700 w.

5776. How to Select a Slide Rule. William Cox (As indicated by the title this is a practical article designed to aid in and extend the use of the slide-rule in mechanical and other computations). Mach–May. 800 w.

5777. Strength of Hydraulic Cylinders. Juan de D. Tejada (General discussion with rules for calculation). Mach–May. 1700.

*5804. The Strength of Cylindrical Shells. F. Keelhoff (Contribution to a subject recently much discussed in *Engineering*. Mathematical in character). Engng–April 24. 600 w.

5836. The Power Plant at Pelzer, S. C. (Illustrated detailed description of one of the most interesting and important water-power developments in the South). Eng Rec–May 2. 2200 w.

*5843. Horse Power of Windmills (General discussion with a half-tone illustration of a flour mill in Holland operated by wind power). Am Miller–May 1. 400 w.

†5873. A Study of the Proper Method of Determining the Strength of Pump Cylinders. Charles W. Kettell (Read before the Am. Soc. of Mech. Engs. A method of analysis for the determination of the stresses in long horizontal pump cylinders, usually made with an upper and lower valve deck). Trans Am Soc Mech Eng–Vol XVII. 2200 w.

†5875. Spring Tables. G. R. Henderson (Tabulated data for determining the various properties of a helical or elliptical spring, and considered preferable to diagrams on logarithmic cross-section paper, presented by the same author at the Dec. 1894 meeting. Read before the A. S. M. E.). Trans Am Inst of Mech Engs–Vol XVII. 2000 w.

†5879. A Hydraulic Dynamometer. James D. Hoffman (Read before the A. S. M. E. Illustrated detailed description of this machine, constructed at Purdue University for the purpose of tests on the application of cutting edges to iron). Trans Am Inst of Mech Engs–Vol XVII. 1000 w.

†5884. Structural Steel Fly-Wheels. Thomas E. Murray (Read before the A. S. M. E. Deals with methods for constructing fly-wheels which will not be liable to burst, and takes the ground that the use of cast-iron for this purpose has reached its limit. Structural wheels of steel are advocated and an example of the construction of such a wheel is illustrated and described). Trans Am Inst of Min Engs–Vol XVII. 1400 w.

†5885. Topical Discussions and Notes of Experience. William Sangster, W. F. M. Goss and John H. Cooper (Read before the A. S. M. E. Topics discussed were clamp-fits, power to drive disk fans, effect of fire on machinery, and how to locate a steam-engine condenser. Further elucidation of these subjects was requested). Trans Am Inst of Mech Engs–Vol XVII. 1400 w.

†5888. Hollow Steel Forgings. H. F. J. Porter (Read before the A. S. M. E. Describes and illustrates a method of forging hollow shafts or rolls, and gives substantial reasons for adopting it. Formulæ for twisting moments, etc., of such forgings are given, and some accounts of notable forgings of this kind are presented). Trans Am Inst of Mech Engs–Vol XVII. 2800 w.

†5892. Water Renaissance. John Birkinbine (The author reviews the recent large increase of the use of water-power in the industries of the world, resulting from the electrical distribution of power from power stations located on streams, and discusses a possible farther increase to meet the demands of power for irrigation. Incidentally some remarks are made on the water supply of cities). Pro Eng's Club of Phila–April. 3000 w.

5893. The Uses and Advantages of a Public Supply of Compressed Air for Pumping or Raising Water. Frank Richards (It is pointed out that a pump could be made exactly proportionate for this purpose, and that compressed air in a well designed pump may be economically used for pumping. Considerations which should influence design follow). Am Mach–May 7. 1800 w.

5894. Some Dividing Tools. A. H. Cleaves (Illustrates and describes a number of methods of doing different kinds of dividing work). Am Mach–May 7. 800 w.

5910. The Transmission of Power by Wire Ropes. William Hewitt (This paper presents new formulæ and tabulated results differing from those hitherto used, based on the fact that the bending of wire laid in rope around a sheave gives a less resistance than the bending of straight wire of the same size around a sheave of the same size, as previous writers have assumed). Eng News–May 7. 1200 w.

We supply copies of these articles. See introductory.

MINING & METALLURGY

Lessening the Danger of Blasting in Fiery Pits.

THE principal danger in blasting in gaseous mines, or coal mines containing much dust, lies in the fact that such gases or dust are liable to ignition from the flame of the explosive or fuse used, which would produce a disastrous explosion in the mine. Speaking of this matter, the *Colliery Guardian* (Mar. 6) quotes from an article by Mr. Franz Brzezowski in the *Oesterreichische Zeitschrift für Bergund Hüttenwesen*, as follows:

"There are now several reliable systems of central-fire cartridges in existence, such as the electrical fuses (high tension, or quantity—the latter for choice, as offering less danger of igniting the gas by sparking); Tirmann's percussion detonator, which, out of 400,000 shots, only gave 0.2 per cent. of miss-fires; the improved Lauer friction fuse; and the Jaroljmek water-cartridge.

"Von Lauer's experiments go to prove that the disruptive power, and, therefore, the danger, of an explosive is modified by the strength of detonator employed, and it has been found with the Trauzl method the volume of gas evolved from 15 grains of explosive varied with the detonator as follows:

	Detonator Cap.			
	1 grm.	2 grms.	3 grms.	
Wetterdynamit.	350	356	—	cubic meters.
Westfalit.....	350	546	618	"
Progressit	354	566	590	"
Ferifractor	—	560	—	"

"The decrease of security resulting from the use of large detonators may be gathered from the fact that a blown-out shot of 500 grams of westfalit fired by a 1-gram detonator did not explode a 7 per cent. mixture of firedamp, whilst 300 grams ignited by a 3-gram cap under similar conditions did. It is, therefore, evident that the term 'safety,' as applied to these explosives, is only relative.

"Concerning the constitution of the explosives suitable for fiery pits, 'safety explosives,' with the exception of 'wetter'-dynamite (a mixture of dynamite and crystal soda), mostly consist of ammonium nitrate (up to 96 per cent.), mixed with aromatic hydrocarbon compounds (benzol, naphthalin, anilin) or their nitro-compounds, resins or fats, and can only be fired by powerful detonators, their safety depending on the smallness of the flame produced. These substances are completely harmless in themselves, being proof against shock or flame, and can be handled with red-hot iron tongs or exposed to the flame of the oxyhydrogen blow-pipe without exploding, merely fusing and burning with a small flame, and ceasing to burn when removed from the fire. These properties are valuable for mining purposes, as none of these preparations give deflagrating shots. 'Wetter'-dynamite will deflagrate if the detonator is insufficiently powerful, but the others under consideration simply refuse to explode, under similar conditions, and they have the further advantage over dynamite of not freezing except at very low temperatures,—seldom, therefore, requiring to be thawed out. In fact, they can only be fired by means of very powerful caps, and, the closer they are compressed, the stronger will the cap have to be. When of a density of 1.6 to 1.7, a 2-gram cap or dynamite fuse is insufficient.

"The most convenient density is 0.8. The dispersive power increases, and the security decreases, with the proportion of hydrocarbon compounds, and with the strength of detonator employed. Ammonium oxalate or the salts of chlorine, bromine, and iodine diminish the efficiency but heighten the safety, of these explosives. On the other hand, amongst the disadvantages may be noted their low density—which necessitates wider boreholes—and especially their hygroscopic power, which, however, may be counteracted by careful packing.

"The value of 'safety explosives' may be judged from the following experiments with 'progressit,' a preparation which for security is found to be surpassed by none:

150 grams of progressit could not be exploded by a 2-gram cap, when lying free in a mixture containing 2 per cent. of gas and 3 kilos. of coaldust, whereas 300 grams of No. 1 dynamite exploded with violence; 150 grams of progressit lying free in presence of 10 per cent. of gas and 3 kilos. of coaldust were exploded by a 1-gram cap, but failed to ignite the mixture in any of the ten tests applied, and in only two out of four cases did a 2 gram cap explode the mixture; 400 grams of progressit lying free in a mixture containing 7 per cent. of gas and 3 kilos. of coaldust and fired with a 2-gram cap did not produce ignition.

"The means at present at disposal for combating the danger of exploding firedamp in blasting are briefly: the central-fire cartridge; moss stemming; good quality paper for covering the cartridges; safety explosives (up to the maximum charge of each); removal of suspended coaldust by spraying; and, finally, the entrusting of the operations to a skilled workman."

Another Impending Gold Boom.

ACCORDING to *Machinery* "special attention is now being directed to New Zealand by reason of the signs of an impending mining boom. In this colony the facilities for economical gold mining are exceptionally good, so much so that some of the largest financiers, including Messrs. Rothschild, are now largely interested in New Zealand gold mines. Another 100-per-cent. dividend was declared recently by one of the companies working gold mines in that colony, the products from authentic sources being that the first 720 tons of quartz milled produced 725 ounces of gold, the next 200 tons 214 ounces of gold, and the next 400 tons 463 ounces of gold; and from a cablegram dated March 7 we learn that 'the latest important discovery incontestably proves five feet of gold reef worth 2 ounces per ton.' And a further report adds that the 200-feet level is turning out ore which gives 10 ounces of gold to the ton, and that the 300-feet level is producing ore which gives 20 ounces of gold to the ton."

"Gold was discovered in 1842, but was not worked until 1852, when the mines of Coromandel first attracted attention to the district of Cape Colville peninsula, which still forms the chief center of true lode-mining operations in New Zealand. The yield from these mines was, up to a few years ago, over four and a half million sterling, but this is small when compared with the quantity of alluvial gold obtained in the south island on the western coast."

"However, the principal quartz mines in the north are in the Coromandel and Thames districts, about thirty miles apart. In these localities the reefs have been proved to a depth of over 600 feet below sea-level, but the best mines have as yet been principally confined to the decomposed and comparatively superficial rock. Veins have been discovered and gold obtained at all levels on the ranges from sea-level to an altitude of 2,000 feet. The quantity of gold that has been obtained from some of these reefs is very great, and for a considerable distance the quartz has yielded very uniformly at the amazing rate of 600 ounces to the ton. Such reefs have, however, been exceptional in New Zealand, as elsewhere."

"The present stir in the gold industry is centered on the Tokatea Hill, in the very heart of the Hauraki goldfields, one of the richest gold-bearing districts of New Zealand. This is on the north-eastern side of the north island, and is located on the same line of reefs as the famous Hauraki and Kapanga mines, whilst it is surrounded by other noted producers. According to the government reports for the year 1895, referring to the Coromandel district, 'there is a highly auriferous belt of country from the Tokatea hill to the ocean beach, going through the Kapanga, Blargrove's freehold, and there is no part of the Coromandel district that is more worthy of being prospected than the Tokatea hill. Quartz containing six ounces to the pound has repeatedly been found, and in one claim sheets of solid gold have been obtained' (The Annual Government Report for 1895, by Mr. H. A. Gordon, M. A. I. M. E., F. G. S.) Al-

though the principal quartz mines for gold are in the Thames and Coromandel districts, near Auckland, in the north island, several auriferous reefs are extensively worked in the Otago, Westland, and Nelson goldfields in the south island. There is very good reason to believe that quartz mining in New Zealand is still in its infancy, and that its indefinite extension can be ensured by the judicious application of more capital and the introduction of suitable machinery."

"In the north island alluvial mining is not carried on to any appreciable extent, but in the southern portion of the colony, the alluvial deposits are of enormous extent and value; indeed, with the exception of Canterbury, where gold has not been found in paying quantities, almost the whole area is distinctly auriferous, . . . especially in the districts of Otago, Westland, and Nelson, in which mining operations are carried on over an area of 20,000 square miles. The auriferous sand, or gold drift, as it is called, is of three kinds:

"1. That which is found in the bed of rivers, and which is worked by small parties of miners, as the process requires no large expenditure of capital to effect the separation of the gold.

"2. Thick deposits of gravel of more ancient date, occupying the wider valleys and the flat country, from which the gold can only be obtained by means of considerable expenditure and large engineering work for the purpose of bringing a supply of water. . . .

"The third kind of gold sand or drift is that found along the sea-coast, where the continual wash of the waves produces a shifting action of the sands which are brought down by the river and drifted along the shore, thus producing fine deposits of gold. . . ."

"The alluvial diggings at Collingwood were discovered in the year 1858, those at Otago in 1861, and in 1864 the gold fields of Hokitika proved a great attraction to the mining population of New Zealand generally."

"Alluvial mining has always been the most prolific source of gold in New Zealand, and it continues to yield a supply, as in former years."

The article states furthermore that no accurate returns for any definite period can be obtained, the government report for 1895 of 221,615 ounces being, presumably, approximate only; but that it is admitted that two-thirds of the output is derived from alluvial mining. The chief excitement, however, seems to center about the quartz-vein discoveries, which, as an editorial in the same issue of *Machinery* remarks, "seem almost fabulous, yet they are vouched for by an official inspector." The same editorial further predicts that, "in a country where the distances to be traversed are comparatively so small and the facilities for travelling, either by railway or good roads, are so plentiful; where two-thirds of the land is devoted to agriculture and grazing purposes, water is abundant, and corn and meat are within the reach of the poorest,—it is inevitable that the facts to which we have drawn attention . . . . should largely attract the crowds of adventurous emigrants always on the lookout for a short cut to fortune."

A Wonderful Process for Gold Extraction.

IF the claims made for M. de Rigaud's gold-extracting process are even fractionally fulfilled, the cyanid question will lose its importance and interest. Indeed, the representations are so startling that *The Mining Journal, Railway and Commercial Gazette*, in presenting the transcript of the descriptive paper read by M. Camille Grollet before the Société des Ingénieurs Civils de France, feels impelled to remind its readers that it "naturally takes no responsibility for any of the statements therein contained," which are merely reproduced. The brief abstract following is presented in the same spirit.

The process consists of treating auriferous ores with chlorid of sulphur, or, rather, according to the inventor, with tetrachlorid of sulphur,—"an oily liquid of a density of 1.6, brown color, and suffocating odor."

There is, strictly speaking, only one true compound of chlorine and sulphur,—

$S_2 Cl_2$; this has, however, the property which forms the basis of M. de Rigaud's process,—that of holding an excess of chlorine in solution. This excess is simply held in solution, and under the process is "able to act in the nascent state in the very act of being given off." "It is therefore clear that no more powerful, more energetic, or more perfect solvent for gold exists than this chlorid of sulphur, with which neither chlorine by itself nor cyanid of potassium will bear comparison."

The reagent is prepared by "allowing a stream of washed and dried chlorine gas to act upon sulphur heated to 90° C." under precautions of temperature control; the reddish-brown liquid "tetrachlorid" distils over.

It is important to note the cost: "although the property of M. de Rigaud's process of extracting one hundred per cent. of the gold present is of the highest economic importance, the first cost is also a factor which must not be overlooked." This cost, in Europe, is stated to be a trifle under six cents per ton of ore treated, for the reagent alone. The proportion used is said to be in the ratio of one pound of tetrachlorid to five thousand pounds of ore.

"There are two methods of applying this process,—a rapid and a slow one." The rapid process consists simply in introducing the ore and the chlorid of sulphur together into a lead-lined cast-iron drum provided with an agitator, closing the apparatus and starting up agitation. When the reaction is complete, the drum is tipped up, the chlorid of gold strained off, through a filter of asbestos cloth over lead wires, into "special tanks," and the residual ore washed thoroughly with water to recover the remaining solution. This method, exclusive of the precipitation of the gold, requires four or five hours.

It seems evident from this that the original reagent must be used in solution; otherwise, even supposing the drum to hold a 5,000-pound charge, the proportion of the necessary one pound of chlorid of sulphur which would "escape" afterwards would hardly require any "special tanks" to receive it.

It is not made quite clear why this very simple process is not the one employed commercially; but the paper goes on to describe "the slow process, so-called, which is the true process for treatment on a practical scale," and is "still incomparably more rapid than any other known at present." The plant consists of a series of reaction tanks, a pump, and an exhaustion chamber. The reaction tanks are lead-lined iron cylinders, resting on trunnions, so that they may conveniently be tipped over for emptying, and provided with perforated false bottoms, on which asbestos cloth can be arranged to act as a filter during the process, while afterwards the whole false bottom can be dragged out, thus discharging cleanly and quickly the exhausted ore.

The charge is introduced "in the state of liquid mud" (here probably we get the explanation of the dilution of the reagent), then the chlorid of gold, and then the cover is put on. The chlorid of sulphur begins the work, but the "nascent chlorine," which is to complete it, tends to collect on the top of the tank, and must be drawn down again through the ore. This is the function of the pump provided in the plant. The "exhaustion chamber" is simply a convenient washing-apparatus, by which the gases drawn from the reaction tank are passed through milk of lime, to absorb the chlorine, which otherwise would attack and rapidly destroy the pump parts.

The chlorid-of-gold solution does not go through the pump, but collects in the bottom of the reaction chamber below the pump suction, and is drawn off from time to time, whenever its volume (as indicated by a gage glass) shows the necessity.

When "the greater part of the rich chlorid-of-gold solution is drawn off," wash-water is turned in, and the washings collected in separate tanks, where they concentrate by exposure to the air. The gold in the original concentrated solution is precipitated by an excess of sulphate of iron, and the excess reagent is afterward drawn off and used to precipitate the washings.

"The bulk of the gold is left in the form

of a muddy precipitate in the bottom of the tanks. It is chemically pure, and only needs to be dried and melted in the ordinary way." The exhausted tailings "are completely barren, because M. de Rigaud's process extracts the *whole* of the gold contained in them. A works for carrying out the process is being completed at Havre, alongside the Tancarville canal, by the Total Gold Extraction Company, the advantage of the site being the ready discharge of the exhausted tailings into the sea."

Incidental to the process is the partial recovery of both chlorine and sulphur. Interference with the reactions would be caused by the formation of soluble metallic chlorids precipitable by sulphate of iron, and M. de Rigaud does not use his process for ores containing tin, or antimony, or zinc.

A computation is made for a works sufficient to treat one hundred tons of tailings per day. The tailings are assumed to contain ten grams of gold to the ton, and to be purchasable at three francs per ton. Four francs per ton is the calculated cost of all labor, reagents, and expenses, and two francs per ton is set aside for a sinking fund.

This makes a total of nine francs per ton: the returns, "since M. de Rigaud extracts the whole of the gold present," are figured to be (10 grams @ 3 francs per gram) 30 francs per ton,—a profit of 21 on 9, or 233⅓ per cent.

Electric Disturbances in Mine-Surveying.

ELECTRIC lines are extending so rapidly, particularly in districts where a large working population is assembled, that the invasion of the mining regions must be expected as a natural and early development. The installation of electric powers for mine-work also will be accompanied by the creation of magnetic disturbances, which must be guarded against in underground surveying. The experiments of Mr. Lenz in the Westphalian coal-field, noted in *The Engineering and Mining Journal*, have, therefore, a current interest in the United States.

"A point, underground, was selected at a horizontal distance of some 100 yards from the rails of the Bochum-Herne electric railway, and 434 meters (1,420 feet) below it. There, by means of a Fennel's magnetometer with quartz fiber suspension, a series of observations of variation were made, based on a fixed line. The magnetometer was previously compared for a long period with the apparatus in the Bochum town park, and the two instruments were found to coincide almost exactly. The first observation, in September, 1895, was made by day, the second by night, when the line was free from current, and the last again by day. While the curve of the day-results exhibited great irregularities, that of the night-results was perfectly regular and in accord with the magnetic records. The irregularities in quite small intervals of time amounted from 2.7 minutes to 5.4 minutes. As at first it was thought that the deviation might be ascribed to the iron-free safety lamps employed, a third observation was made in the morning, the lighting being effected by a stearine candle. The results were exactly the same as on the first day. As the observations were made at a comparatively large distance from other workings, and as the shaft was 200 yards away, it is evident that magnetic observations can, under such conditions, be only satisfactorily conducted during the night, in the absence of the magnetic current."

The connection of the magnetometer deviations with the electric railway current seems to be very strongly evidenced, but a fuller and more detailed investigation would have still more interest. The remainder of the tests indicate a source of disturbance independent of the use of electric power, and are rather curious.

"Another source of error is the safety lamp. Composed of various metals, the lamp in a hot condition sets up thermo-electric currents, which act on the magnetic needle. In order to obtain information on this point, the author placed six mine surveyors' safety lamps free from iron, one at a time, first in a cold condition, then heated, at the pole of a sensitive magnetometer. Of the six lamps examined, two, when cold, had no action on the

needle, whilst all acted on it when hot. The deviations observed amounted to from 30 seconds to 160 seconds.

"A new benzine lamp that had not previously been used caused a deviation of as much as five minutes. The deviation increased with the temperature of the lamp. A quite new aluminum safety lamp caused the same deviation when cold as when hot. From these results it follows that the mine surveyor, before making magnetic observations with delicate instruments, should carefully test his lamp.

"The influence of slight magnetic properties may be lessened by holding the light in the prolongation of the magnetic axis. With side lighting great care is necessary."

The Mineral Output of Canada.

DR. DAVID T. DAY'S article on the minor minerals of the United States, concluded in this number, will give an interest to a comparison with the figures of Canadian mineral production for 1895. The preliminary statistical table, prepared by the division of mineral statistics and mines of the Canadian geological survey, has just been published, and is thus noted in the *Iron Age*:

"It shows the value of the total production in 1895 of minerals, both metallic and non-metallic, at $22,500,000, of which $6,370,146 was metallic and $15,875,197 was non-metallic, with $254,657 as the estimated value of mineral products not returned. The total production in 1894 was $20,900,000; that in 1893, $19,250,000; that in 1892, $19,500,000; that in 1891, $20,500,000; that in 1890, $18,000,000; that in 1889, $14,500,000; that in 1888, $13,500,000; that in 1887, $12,500,000; and that in 1886, $12,000,000. From this last it will be seen that the production of last year was the largest in any one year during the past decade, and that there was an increase of $10,500,000 from 1886 to 1896. The metallic productions last year consisted of copper of the value of $949,229; gold, $1,910,921; iron ore, $238,070; lead, fine in ore, &c., $749,966; mercury, $2,343; nickel, fine in ore, &c., $1,360,984; and silver, fine in ore, &c., $1,158,633. The non-metallic productions were: asbestos, $368,175; baryta, $168; chromite, $41,301; coal, $7,774,178; coke, $143,047; fire clay, $3,492; graphite, $6,150; grindstones, $31,532; gypsum, $202,608; limestone for flux, $32,916; manganese ore, $8,464; mica, $65,000; ochers, $14,600; mineral water, $111,048; molding sand, $13,530; natural gas, $423,032; petroleum, $1,201,184; phosphate, apatite, $9,565; precious stones, $1,650; pyrites, $102,594; salt, $180,417; soapstone, $2,138. The production of last year exceeded that of the highest amount in any previous year by $2,000,000, the highest amount in any previous year being $20,500,000, which was reached in 1891. It is expected that the returns for the current year will show a still further increase, as the development of the mineral resources of British Columbia is exhibiting great progress."

Cuban Iron Mines.

THE IRON AND COAL TRADES REVIEW (Mar. 27), commenting upon the resources and railways of Cuba, says:

"Cuba is well known to have large resources in the form of iron ore of excellent quality, which have been developed for a considerable time past by American enterprise. The ore ranges from 57 to 62 per cent. of iron, and is remarkably free from phosphorus. From the years 1884 to 1893 the total quantity produced was about 2,093,000 tons, commencing with 21,798 tons in 1884, and ending with 363,000 tons in 1893. The principal ore-exporting concerns are the Juragua and the Ligua Iron Companies. The ore is chiefly mined in open cuts. The Cuban bessemer iron-ore range, as it is described in the United States,—where the ore is wholly consumed,—is east of Santiago de Cuba, and extends in length about 22 miles. The iron outcrops average in width about 300 feet, the surface between them being composed of ore-bearing ground, with dykes of rock varying from 50 to 100 feet in width. Quite recently a new company, styled the Spanish-American Company, has gone into the business, and built docks and railroads. The iron-ore beds are 8 miles from the coast, and at an average elevation of 4,000 feet.

"The Sabinilla and Murato Railroad, which runs north from the port of Santiago de Cuba to Enramadas, has recently been purchased by an American company, who are extending it to some rich deposits of manganese in the interior, which they also own. The road is being thoroughly overhauled, and new iron bridges, track material, rolling stock, and machinery are being introduced.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

*5264. The Vast Importance of the Coke Industry. Ill. John Fulton (Showing the value of coke for metallurgical and domestic uses, and describing the various types of coke-ovens with their advantages and disadvantages). Eng Mag–May. 5000 w.

5332. The Canadian Iron Trade (From a commercial standpoint this article is very interesting. It shows that the imports into Canada from the United States are more than double those from England, and that the British trade is rapidly decreasing). Ir Age–April 9. 1600 w.

5389. Blast Furnace Heat Balance Sheet. H. H. Stoek (Translated from the French of M. de Billy's "Farication de la Fonte." Formulæ are derived and all the heat generated in the furnace accounted for). Eng & Min Jour–April 11. 1000 w.

†5395. The Wastage of Gold in the Course of Preparing Jewelry in Bengal. Issan Saran Chakrabarti (The loss in melting is usually a little over one-fourth pie per tola of gold melted. An exposition of Indian goldsmith practice). Ind Engng–March 14. Serial. 1st part. 2000 w.

*5396. The Iron and Steel Industries of South Russia (Illustrated description of the Briansk Company's Alexandroffsky Iron and Steel Works). Ir & St Trs Jour–April 4. 900 w

*5402. Steel Castings and Malleable Iron. C. H. Benjamin (Record of tests made in these materials in tension, compression and shear). Digest of Phys Tests–April. 1200 w.

5407. The Government Iron and Steel Works at Han-yang, China. G. Toppe (Description by the director general, of the Government Iron and Steel Works, consisting of two 60 ft. blast furnaces and mills for turning out merchant iron and steel and rails. There are 34 Europeans employed in the works). Am Mfr & Ir Wld–April 10. 1200 w.

*5410. The Lackawanna Steel Works, United States (Brief description, with cut of the rail conveyer and loader). Ir & Coal Trs Rev–April 3. 1700 w.

*5411. A Blast-furnace Shaft without Brickwork. Franz Büttgenbach (Translated from the *Oesterreichische Zeitschrift für Berg-und-Hüttenwesen*. The author has built furnaces with three rows of bricks and would build one having no bricks, simply an outside sheet-iron casing). Ir & Coal Trs Rev–April 3. 900 w.

*5413. Coal Dust Fuel in the Brown Coal Briquette Industry. Dr. Kosmann (From the *Berg-und Huttenmännische Zeitung* showing the heat efficiency of coal dust compared with coal). Col Guard–April 2. 1000 w.

*5415. Lighting of Blast Furnaces. F. Bicheroux (Prize memoir of the Liège section of the Belgian Association of Mining Engineers. Translated from *La Revue Universelle des Mines et de la Metallurgie, etc.* A description of the system coming into vogue of lighting furnaces by means of grates). Col Guard–April 2. Serial. 1st part. 2600 w.

*5460. Charters Towers Cyanide Works (Brief description of the method used in treating sludges and concentrates). Aust Min Stand–March 5. 700 w.

5465. The Manufacture of Bessemer Steel (Brief description, illustrated by a view in a continental works, from *Black and White*). Sci Am Sup–April 18. 1100 w.

5468. The Production of Open Hearth Steel in the United States (Statistical summary principally from the Bulletin of the American Iron & Steel Asso). Ir Age–April 16. 900 w.

5469. Apparatus for Treating Wire Rods. C. W. Bildt (Translated from *Jernkontorets Annaler*. Scale is removed and oxidation prevented by running the wire or rod through water after coming from the rolls, till it has attained about a low cherry-red heat. The apparatus is illustrated and a diagram shows the resulting properties). Ir Age–April 16. 1100 w.

5471. The Basic Open Hearth Process at Granite City, Ill. (The steel furnaces are illustrated by plans and sections, and are well described. Data and analyses are included). Ir Age–April 16. 900 w.

*5549. The Manufacture and Consumption of Steel Rails (Showing that an enormous quantity of steel is used in the manufacture of rails, more than 47 millions tons of rails having been produced since 1882. The accompanying statistics show the distribution of these rails and the effect of renewals on the market). Ir & Coal Trs Rev–April 10. 1600 w.

5629. Alloys of Iron and Nickel. M. Rudeloff (From the *Verhandiungen des Vereins zur Befrödeɪnug des Gewerbfleisses*. A number of results are given on expansion by heat analyses, tensile, compressive, and drop tests). Ir Age–April 23. 800 w.

*5665. The Manufacture of Iron and Steel in India (Some account of modern work in India in the manufacture of iron and steel. In most establishments iron and steel continue to be made on methods of unknown antiquity. The

We supply copies of these articles. See introductory.

reasons for non-success of modern attempts are given). Ir & Coal Trs Rev–April 17. 2000 w.

*5666. The Manufacture of Wrought Iron. James Kerr (Describing the conditions of the puddler and the puddling process as they were twenty-five years ago and as they are to-day, dealing with practical work and economy). Ir & Coal Trs Rev–April 17. 1800 w.

*5674. Complete and Cheap Gold Extraction. Camille Grollet (M. de Rigaud's process, which consists of treating the ores with tetra-chloride of sulphur. Abstract of a paper read before the Société des Ingéniéurs Civils de France). Min Jour–April 18. 2500 w.

5677. Commercial Tempering. H. K. Landis (The tempering and annealing of steel in large masses. The operation is briefly described, and a table is given showing the effect). Ir Age–April 30. 1700 w.

†5731. The Volatilization of Silver in Chloridizing-Roasting. L. D. Godshall (A reply to the criticisms of Mr. Stetefeldt upon a former paper). Trans Am Inst of Min Eng–April. 2700 w.

†5732. The Mobility of Molecules of Cast-Iron. A. E. Outerbridge, Jr. (A contribution to the discussion of the Physics of Cast Iron. Tests proving that, within limits, cast iron is materially strengthened by subjection to repeated shocks or blows). Trans Am Inst of Min Eng–April. 3300 w.

†5733. The Embreville Estate, Tennessee. Guy R. Johnson (A brief description of the Embreville property and the iron made there). Trans Am Inst of Min Eng–April. 2000 w.

†5734. The Effects of Additions of Titaniferous to Phosphoric Iron-Ores in the Blast Furnace. Auguste J. Rossi (Some very curious and unexpected results obtained in experimenting in mixing these ores). Trans Am Inst of Min Eng–April. 1500 w.

†5737. The Effect of Expansion on Shrinkage and Contraction in Iron Castings. Thomas D. West (Contribution to the discussion of "Physics of Cast-Iron"). Trans Am Inst of Min Eng–April. 3800 w.

5763. Bessemerizing Nickel Matte. H. W. Edwards (Notes made from the result of work from 1891 to 1894, when the author had charge of a nickel smelting plant in Sudbury district, consisting of two blast furnaces and a set of Bessemer converters (Manhes modification). Eng & Min Jour–May 2. 1500 w.

5765. An Improved Process of Extracting Gold Ores. William M. Grosvenor, Jr. (Description of experimental plant established at Cripple Creek, and that has been in operation about seven months. The process has been patented by J. W. Bailey of Denver. The plant is interesting in its complete automatic and rapid operation). Eng & Min Jour–May 2. 1500 w.

†5783. The Electro-Metallurgy of Aluminum. Joseph W. Richards (Electro-metallurgy is defined, the methods used are classified, the operations for which each is capable of being used are enumerated, as an introduction to the subject. The properties of aluminum are considered and the different kinds of electric processes are taken up in detail, with illustrations). Jour Fr Inst–May. 6200 w.

5789.—75 cts. Treatment of Roasted Gold Ores by Means of Bromine. Richard W. Lodge (Reprinted from Trans. of Am. Inst. of Min. Engs., Florida meeting, March, 1895. Experiments where bromine seemed to have many advantages over chlorine). Tech Quar–Dec. 800 w.

5790.—75 cts. The Cyanide Process as applied to the Concentrates from a Nova Scotia Gold Ore. Richard W. Lodge (Reprinted from Trans. of Am. Inst. of Min. Engs., Florida meeting, March, 1895. Work of W. A. Tucker which seems to disprove the view that the presence of arsenic interferes with the extraction of gold by the cyanide method). Tech Quar–Dec. 800 w.

†5820. The Cassell-Hinman Gold and Bromine Process. Parker C. McIlhiney (This process is for the extraction of gold from low grade ores, and those which will not give up their gold to amalgamation). Jour Am Chem Soc–May. 2200 w.

†5822. The Copper Assay by the Iodide Method. Albert H. Low (The method is described and the writer states that for most accurate technical work he prefers it to all other methods). Jour Am Chem Soc–May. 1600 w.

5848. Notes on Gold Milling. E. B. Preston (Considers the importance of the site, the construction, mill details, and practices in the first part). Can Min Rev–April. Serial. 1st part. 12000 w.

*5855. The British Aluminum Works at Fayers (Illustrated description). Elec Eng, Lond–April 24. Serial. 1st part. 1600 w.

†5928. The Manufacture of Iron and Steel in Southern India. W. Naylor, in the *Madras Mail* (An account of the successful introduction of European methods, and the excellent quality of the steel). Ind & East Eng–April 11. 1700 w.

5934. Notes on the Hydrometallurgy of Gold and Silver. W. Geo. Waring (Calling attention to facts in hydrometallurgy that are not well understood, and stating that the advances of the present day do not consist in the discovery of new processes, but in improvements in manipulation of the old and well-founded methods). Eng & Min Jour–May 9. 2700 w.

Mining.

5321. The Hydraulic Gravel Elevator (Description of the operation of a hydraulic giant and elevator, with illustrations of each in operation. Instances are given where the gravel is elevated from 40 to 96 feet). Min & Sci Pr–April 4. 1600 w.

*5390. Golden New Zealand (Introduction to the detailed report of the Minister of Mines, giving the history of the past year in a summarized form). Min Jour–April 4. Serial. 1st part. 4300 w.

*5391. Mining in the State of Chiapas, Mexico (Read before the Inst. of Mining and Met-

allurgy. Transportation, climate, labor, geology, etc., are intelligently described). Min Jour–April 4. 3800 w.

*5412. Underground Haulage by Electric Locomotives. Léon Sindic (Communication to the Charleroi section of the Union des Ingénieurs de Louvain. Showing how the system is applied both with accumulators and by the use of a cable, with estimates for each case). Col Guard–April 2. 2700 w.

*5457. Flux for the Smelters (Description of a limestone quarry and plant extracting stone for the smelters. Illustrated by two views). Aust Min Stand–March 5. 800 w.

*5462. Lansell's Pneumatic Water-Raiser and Ventilator (Description of the pneumatic method of draining mines by means of successive lifts, to a depth of 1560 ft. A section illustrates the arrangement as used at a Bendigo, Victoria, Mine). Aust Min Stand–March 12. 1200 w.

*5463. The Auriferous Beach Sands on the North Coast (N. S. W.) J. E. Carne (A full description from the annual report of the New South Wales Department of Mines) Aust Min Stand–March 12. Serial. 1st part. 5200 w.

5529. Wire Rope Tramway at the Bunker Hill and Sullivan Mines, Idaho (General description illustrated by profiles and two excellent views. It has been operated since 1890, with a great saving in transportation expenses. There is one span of 1100 ft. over a town, at a height of 125 ft. above the houses). Eng & Min Jour–April 18. 600 w.

*5531. Experimental Trials with an Electrically-Driven Winding Engine. Ingenieur C. Köttgen (A technical paper, from *Glückhauf*, giving the results of experiments made by Siemens and Halske, showing that equal ease in handling and safety can be obtained, as with steam or compressed air. The motors were direct gear connected). Col Guard–April 10. 2500 w.

*5532 Periodicity of Fire-damp. A. Doneux (From *Cosmos*. Supplementary to a previous article on the same subject). Col Guard–April 10. 550 w.

*5533. How a Mine May Be Dry but not Dusty. George Fowler (Paper read before the Chesterfield and Midland Counties Institution of Engineers. The author says that watering a mine to prevent dust may not be necessary; that dust is produced principally in transporting the coal through the mine, and recommends closed cars). Col Guard–April 10. 2400 w.

*5574. The Mineral Wealth of New Zealand (An article setting forth the varied resources and the exceptional facilities for economical gold mining, with a map giving the chief localities of the different ores). Mach, Lond–April 15. 5000 w.

5630. A California Electric Mining Plant (A 300-h. p., 30-inch Girard water wheel is coupled direct to a 150-h. p., 1000-volt direct current electric generator driving a pump which supplies water to the gold sluices). Min & Sci Pr–April 18. 800 w.

5631. California Will Be the Leader (A general article descriptive of the gold resources of California). Min & Sci Pr–April 18. 3000 w.

†5633. The Coal Supply of India (A brief résumé of the coal mining industry in India. From the *Pioneer*). Ind & East Eng–March 28. 1800 w.

5662. Electricity for Mine Pumping. William Baxter, Jr. (Considering the advantages of electricity as compared with compressed air and steam, both from the mechanical standpoint and efficiency). Eng & Min Jour–April 25. 1700 w.

*5670. Firedamp, the Formenophone and the Indicating Safety Lamp. Ernest Hardy (A communication from the inventor of the formenophone as to the application of sonorous vibrations for analyzing gases of different density, with brief discussion of other methods for indicating the percentage of firedamp). Col Guard–April 17. 2000 w.

†5735. The Hydraulic Elevator at the Chestatee Mine, Georgia. W. K. Crandall (The construction and operation of a type of portable hydraulic lift or gravel-elevator, with a description of the practice at the Chestatee mine). Trans Am Inst of Min Eng–April. 1300 w.

5764. Ore Deposits of the Little Rocky Mountains, Montana. Walter Harvey Reed (Notes upon the geology and ore deposits of this region made by the writer during a visit to the region as geologist for the government). Eng & Min Jour–May 2. 1900 w.

5766. The Microscope as Used in Mining. J. A. Edman (Address delivered before the Microscopical Society in San Francisco. Showing that the microscopical study of ore deposits to be not only very interesting, but helpful if not absolutely necessary in determining the physical conditions of the ore before deciding on a plant and milling process). Min & Sci Pr–April 25. 2500 w.

5817. Historical Notes on Early Plans for Coal Washing. F. J. Rowan (From the *Transactions* of the Mining Institute of Scotland. Description of some systems the completeness of which are surprising because of their early date). Am Mfr & Ir Wld–May 1. 1100 w.

*5861. The Law Relating to Truck and Checkweighing (An official memorandum drawn up by the direction of the Secretary of State for the Home Department. The checkweighing clauses in the Coal Mines Acts are considered atlength). Col Guard–April 24. 10000 w.

*5862. Gob-Lowering Balance with Water-Brake (From a communication by the Management of the Saint-Eloy Collieries, Puy de, Dôme, France, to the Société de l'Industrie Minérale, Saint-Etienne. Illustrated description). Col Guard–April 24. 1200 w.

5864. Notes on the Grand Lake Coal Field of New Brunswick. R. G. E. Leckie (Map with sections of surface seam, and description of location, area, analysis, cost of mining, etc). Can Min Rev–April. 1800 w.

*5904. Placer Mining. Ill. Arthur Lakes (A general and specific account of placers, their formation, distribution and the construction and development of the different machinery and de-

vices used in working them). Col Eng-May. 5800 w.

*5906. Compressed Air Haulage (Description of the plant at the Susquehanna Coal Co.'s No. 6 Colliery. Some novel features peculiar to this plant which successfully meet conditions existing in many coal mines are illustrated and described. Editorial also reviews compressed air as a motive power). Col Eng-May. 5000 w.

*5926. Coramba Creek Goldfields (N. S. W.) (Describes the general geological features, and the mines). Aust Min Stand-March 26. Serial. 1st part. 3000 w.

Miscellany.

*5269. Minor Minerals of the United States. David T. Day (Classifying minor minerals according to conditions of supply and demand, and stating the sources and uses of each). Eng Mag-May. 3900 w.

5308. The Inventor of the Bessemer Process (Editorial review and criticism of the claims made for William Kelly as the original inventor of the Bessemer Process, by J. D. Weeks in the annual address of the American Institute of Mining Engineers, and also a review and approval of Sir Henry Bessemer's answer to Mr. Weeks). Ry Age-April 11. 1400 w.

5388. The Mineral and Metal Production of the United States in 1895 (The annual statistical report giving the production in quantity and value, of 69 mineral and metallic substances produced in the United States, showing an increased production in 1895 over 1894 of 15.5% in value). Eng & Min Jour-April 11. 5400 w.

*5449. Missouri Building and Ornamental Stones. Charles R. Keyes (This proposes to be a well illustrated and interesting series of articles. Special attention is given to geological characteristics, and this will have weight being written by the state geologist). Stone-April. Serial. 1st part. 1200 w.

*5450. American Slate in Great Britain (Comments upon the probable large future trade for American slate in Great Britain, by *The Quarry* of London; with the editor's opinion upon the subject). Stone-April. 1300 w.

*5451. Stones from Norway and Sweden. Hern Lund (Description of the soap stone and slate industries, showing their properties and how they are applied). Stone-April. 800 w.

*5452. Building a Business. Fred P. Ronnan, in *Fame* (How a quarry was boomed into a thriving business. An entertaining article). Stone-April. 2200 w.

*5458. The Charters Towers Pyrites Works (Brief description). Aust Min Stand-March 5. 500 w.

*5459. The Yalgoo (Murchison) Gold Field (W. A.) H. P. Woodward (Brief description from the government geologist's report). Aust Min Stand-March 5. 1100 w.

*5461. Kerosene Shale in New South Wales —The Genowlan Mine (General description with production and analysis). Aust Min Stand-March 12. 1700 w.

*5530. The Lancashire Coal-field. M. E. (A short geological description showing arrangement of strata). Col Guard-April 10. 1200 w.

5658. Some Considerations as to Coke (Editorial review of the present situation of the coke supply). Ir Tr Rev-April 23. 1200 w.

5659. Mesabi Ores and Top Explosions. F. E. Bachman (A letter giving an account of experiments made which seem to support the writer's theory that the prevention of explosions is reduced to the selection of an ore mixture not depositing an excessive amount of carbon). Ir Tr Rev-April 23. 600 w.

5661. Cost of Gold Production (Editorial review of the present cost of milling gold ores, with reference to the report of the Robinson Gold Mining Co., which is regarded as a model of clearness and information of technical value). Eng and Min Jour-April 25. 1800 w.

*5669. State of Mining and Metallurgy in France (From a report founded upon data collected by the Ingenieurs des Mines during 1895, to the French Minister of Public Works). Col Guard-April 17. 2200 w.

†5736. The Assay by Prospectors of Auriferous Ores and Gravels by Means of Amalgamation and the Blowpipe. William Hamilton Merritt (The method of field testing of gold ores, as practiced in the Kingston School of Mining, is described, pointing out some points in which it differs from that presented in a recent paper by R. W. Leonard). Trans Am Inst of Min Eng-April. 1500 w.

†5739. Standard Physical Tests for the Product of the Blast Furnace, and their Value. Ill. Thomas D. West (Discussion of this work. The writer claims that progress in the science of either making or mixing iron requires the study of the physical as well as the chemical properties). Trans Am Inst of Min Eng-April. 5000 w.

†5823. The Deposition of Gold in South Africa. S. Czyszkowski. Translated by H. V. Winchell (The subject deals with the theories of the origin of the gold deposits in the unique auriferous region of the Transvaal. Origin of mineral waters. Circulation of waters, both surface and deep seated. Thalwegs and metalliferous strata (niveaux). General geological sketch of South Africa. Age of the gold deposition. Deposits of Witwatersrand. The terrane enclosing the reefs and origin of the latter. Deposits of the "de Kaap" district. Structure of the terrane enclosing these deposits. District of Lydenburg.—Mashonaland.—Matabeleland Origin and mode of formation of the reefs. Orogenic and metalliferous phenomena of South Africa. Analogy with the South of Spain, and ten conclusions). Am Geol-May. 7000 w.

*5905. The Dayton, Tenn., Disaster. W. M. Gibson (Full particulars and descriptions of the mine previous and subsequent to the explosion of the 20th of Dec. last whereby 28 men and boys lost their lives). Col Eng-May. 3000 w.

*5925. The Scientific Exploration of Central Australia. W. A. Horn (The origin of the expedition, the natural features of the country, Chambers' pillar, Ayers' Rock, and the climate are described). Aust Min Stand-March 26. 3600 w.

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

Increasing Profits in Gas Manufacture.

DR. F. AUERBACH, in the *Progressive Age* (April 15), thinks "too little attention has been paid to a detail which would not only serve to reduce the expenses of gas manufacture, but would sensibly augment the receipts. This is the purification of the gas. While the other by-products—coke, tar, ammonia water—have become a source of revenue, and their fluctuations in price closely watched, spent purifying materials are regarded as valueless, giving a profit only in extraordinary circumstances.

"This indifference is especially unjustifiable, as the results in other countries—Germany, for example—have demonstrated the possibility of rendering the spent materials salable at a good price. It must not be thought that the large works only are in position to attain this result. When it is a question of refinements that render necessary great constructions or costly additions, the large works undoubtedly have the advantage. This is not the case, however, with purification, where all that is necessary is to take some precautionary measures, when the profit will follow of itself, and, moreover, a profit that is very great in proportion to the expense incurred, and due to the great value of cyanids. Since enormous quantities of cyanids have been consumed in the extraction of gold in the mines of Africa and other countries, the demand has largely increased, and the saturated purifying materials of gas-works have become far more valuable, as it is from them principally that the cyanids were obtained. This explains why manufacturers of prussiate of potash pay to-day over eight cents a pound for the Prussian blue contained in their goods." The gains possible to be made under these conditions are indicated as follows: "Under these conditions, it is evident that gas-works have every interest in increasing to the utmost the proportion of Prussian blue contained in their materials. Assume, for example, the fundamental price of 8 1-6 cents per pound; a material containing 12 per cent. of the blue will have a value of $21 a ton, less the cost of transportation from the gas-works to the prussiate factory, which we will assume to average $3; there remains $18 per ton. By the same calculation, a material containing 6 per cent. will be worth but $8, and one containing 4 per cent. will be worth only $4 a ton. These last figures would be still further diminished by the fact that the prussiate manufacturers have not only the same cost of transportation, but also the same cost of working up the rich materials as the poor, thus compelling them to offer a price that lessens as the amount of blue contained becomes smaller. Many gas companies have already turned their attention to the enrichment of their purifying materials, and are obtaining 10 per cent. and 12 per cent., and we can even mention one case in which 15.2 per cent. is reached.

"Let us now see what increase of profit will result from perfecting this method. A works of moderate size, consuming 200 tons of new purifying material annually, at an expense of $6 a ton, will pay $1,200 a year for its material. These two hundred tons, when increased by the absorption of sulphur and cyanid, will produce 350 tons by the end of the year, if saturated to 12 per cent. At $18.60 per ton, this will be worth $6,510, and the result will be a profit of $5,000, in round figures. If a material containing but 10 per cent. of the blue is obtained, the profit will be $4,000. It is evident that this profit is almost in proportion to the size of the works, but even in the smallest it should exceed $200, and in the largest should reach enormous sums. In fact, Dr. Knublauch, one of the most competent chemists in gas matters, in treating this question in a lecture before the 'Deutsche Verein von Gas und Wasserfachmannern' last year, expressed himself in these terms:

'While materials are often obtained which yield little or no cyanid, a good material yields 800 to 900 francs and more per 10,000 kg. ($16 to $18 per gross ton), and dry purification should to-day be an important source of revenue.'"

Dr. Auerbach agrees with Dr. Knublauch that insufficient condensation before purification exerts a detrimental influence upon purification, and thinks that the quality of oil gasified is of less importance than is usually assigned to it. He states also that analyses of saturated materials taken in a great number of European works has shown that complete success is attainable by employing only a material which, while possessing the property of removing from the gas the sulphur-hydrogen compounds and cyanids, is susceptible at the same time of giving a valuable final product. In France the Laming material is most used. This is composed of sawdust mixed with lime, soaked with a solution of sulphate of iron, and oxidized in the air; but this material does not now conform to the more advanced scientific practice. In England and Belgium materials richer in iron oxid are used. France has begun to use such materials, but this change in practice has not been satisfactory, "the reason being that these materials are not adapted to purification, as other qualities are also necessary. From a chemical point of view, the materials should not contain an appreciable quantity of deleterious substances, such as lime, alkaline or acid salts, and the iron oxid should be in a state susceptible to ready absorption,—that is to say, completely hydrated. From a mechanical point of view, it is, above all, necessary that the material should of itself be so light and porous that it does not become necessary to mix it with light foreign substances, for such mixtures entail extra expense, reduce the strength of the oxid, and lessen the value of the exhausted material.

"Many of the materials sold in commerce do not fulfil these requirements. The artificial products often contain iron oxid in an inactive state; and the natural minerals are too heavy and require a mixture, or too hard and require costly preparation, or contain too much earth and soon become inactive. Few materials unite in themselves all the qualifications necessary to effective purification and good production of Prussian blue, and it is certainly to the qualities of the material that we must attribute the excellent results mentioned above."

Steam Disinfecting Apparatus.

A SANITARY inspector gives in *The Sanitary Record* for March a description of cheap and easily-constructed steam disinfecting apparatus, which he claims to have used with very satisfactory results. The apparatus is designed to take full advantage of the latent heat of steam. An abstract of his description is here made.

The boiler is of the self-contained vertical type, two feet in diameter by four feet high, tested to one hundred pounds per square inch, and of mild steel throughout. It is fitted with usual gages, etc., and is fed with water direct from the town mains.

The disinfecting chamber is cylindrical, of steel, four feet in diameter and six feet long. The door opens full width, and, when closed, is held in place by nineteen 1⅛-inch bolts. The shell is of ⅜-inch plate, the closed end being of 7-16-inch plate, and the door is ⅝ inch thick. To fasten or unfasten the door requires about two minutes.

A combined steam and vacuum gage is fixed on the top, the whole forming a large machine. The cylinder is covered with asbestos one inch thick, in order to conserve the heat. Steam is turned in preferably at the top, and there is a drain pipe attached at the bottom. When the steam is turned in, it remains at the top and gradually displaces the air, which passes out through the drain pipe, and may be heard spluttering out together with the water. Not a particle of steam, however, will escape, until all the air is expelled. The non-conducting qualities of air render this expulsion of all air absolutely necessary, and a pressure of ten, fifteen, or twenty pounds can be obtained in a few minutes.

The last time the apparatus in question was used, a feather-bed, weighing eighty pounds, was rolled in tightly, bound with cord, and placed in the receptacle. As near the center of the bed as possible a registering thermometer was inserted. When taken out, after being exposed for twenty-five minutes to a pressure of fifteen pounds above that of the atmosphere, the thermometer registered 246 deg. F. The full amount of sensible heat due to that pressure is 250 deg. F. The bed then weighed only a quarter of a pound more than when put in the machine, although condensation had been going on freely all the time. Afterwards, the following test was made to see how great a vacuum could be obtained. The chamber was heated with ten pounds per square inch of steam, which was then blown off to atmospheric pressure and all taps closed. After waiting two hours for it to coo. down, the combined pressure and vacuum gage showed the vacuum to be equal to twenty-eight inches of mercury. The test with the feather-bed goes to prove that the thickness of material makes but little difference, so long as the air is expelled; and the expulsion of the air is proved by the good vacuum produced.

To assist in drying the disinfected articles, a coil was made of about forty-two feet of ¾-inch galvanized pipes; but I do not now think this absolutely necessary, as the heat stored in the walls of the cylinder, which weighs over a ton, is sufficient to do all the drying, if the door be opened about one inch to allow the moisture to escape. A sliding basket made of ½-inch tubes, galvanized and lined with wire netting, is provided to receive the clothing, etc.

It has been urged that textile articles may get scorched in such an apparatus. This, however, cannot occur with the use of moist steam. Colors in the cheapest class of materials do not run in the least, while velvet is distinctly improved, as also is crape. It is, however, unnecessary to have the chamber under any pressure, save that of the atmosphere, when using moist steam, for the reason that, as the sensible heat increases with the pressure, so also in almost the same proportion does the latent heat decrease. It will thus be seen that little advantage is to be gained by using steam under pressure, while the risks are greater, and more difficulty is experienced in feeding the boiler.

When a dry chamber is used, the steam may be either superheated by means of a steam jacket containing a higher pressure, or simply by the same heat and pressure in a jacket. In either case the result is the same. No latent heat is used, and air or dry gas would do equally as well.

Tyndall and others have shown that the rapid destruction of some germs requires the application of moist heat, and that dry heat fails to sterilize articles which would be perfectly sterilized in a much shorter time by moist heat, even at lower temperature. The specific heat of most solids is small as compared with that of water; yet, when heated in an atmosphere of steam, they often contain sufficient heat to evaporate all the water condensed upon their surfaces. This, however, would not be the case with porous materials, like clothing. Hence the drying coils in the chamber are a useful adjunct for delivering the articles dry and in good condition, whenever the heat contained in the walls of the disinfecting chamber is not sufficient.

Steam Road-Rollers and Gas Pipes.

THE gas companies in England have found that the use of steam road-rollers has had a bad effect upon gas pipes under streets. We have not heard this complaint from gas companies in the United States; but it is the practice here, at least in the colder parts of the country, to place both water and gas mains deeper in the earth than in England. The trouble has become sufficiently pronounced in England to be made the subject of a paper by Mr. Norton H. Humphrys, Assoc. M. Inst. C. E., printed in *Journal of Gas Lighting*, who asseverates that, while the results of steam road-rolling may be entirely satisfactory to civil engineers, the gas companies do not regard them with complaisance. An abstract of this article follows:

On good roads accustomed to carrying

a large and heavy ordinary traffic, including four-horse vans and traction-engines, and which have been well maintained and kept in good order, the steam roller does not put itself much in evidence. But, when one of these implements is for the first time put upon a by-street or a country road accustomed to small and light traffic, and which has received but little attention in the way of maintenance, beyond an occasional scrape in unusually wet weather and a sprinkling of stones from a cart at rare intervals, the gas engineer becomes more intimately acquainted with "The Luck of Eden Hall" properties possessed by the steam roller than is good for his own comfort or the prosperity of his undertaking. Difficulties from drawn services and fractured mains—ranging from the slight crack of a few inches long up to complete severance of the pipe—become common occurrences.

A comparison of gas pipes with water pipes with reference to their respective requirements shows that this is not because water engineers are more thorough in their work. Following on the lines of the usual rule that, if the gas gives a bad light, the company is at fault, it is agreed that, if the gas pipes break, they must be bad pipes; and many members of corporations, etc., arrive at the conclusion that there must be special negligence in putting down, or selecting, the sections or quality of the pipes to be used for the conveyance of gas. So far from getting any sympathy in their misfortune, which has arisen from causes that could not possibly have been foreseen, the unfortunate gas company is blamed for not laying down pipes at a reasonably sufficient depth, or for purchasing cheap stuff of a rotten or ginger-bread character. A common argument in support of this view is the fact that gas pipes are injured more frequently than water pipes.

The relations between the shape of the roller, its weight, and the mode of using it to the damage done upon the pipes is discussed at length, and the tendency toward using greater weight is depreciated. Water engineers have not been more prudent, nor have they exercised more care or foresight as to possible contingencies. Neither do they generally do their work in a stronger or more substantial manner than do gas engineers. The trouble is simply a natural consequence, due to the different natures of the services performed. The internal pressures to which the gas service is exposed is a mere trifle,—a matter of a few ounces per square inch. But water pipes are subjected to heavy pressure in low levels, representing a large number of pounds per square inch. Gas pipes in themselves are not interfered with by frost, except as regards its effect on the soil surrounding them; but the formation of ice in water-pipes must be prevented, as it not only stops the supply, but also fractures the pipe. It would be as reasonable to adduce the fact that the main sewers are never injured by the roller, as to compare water pipes with gas pipes.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

*5338. Water Gas in Birmingham (Notes on water gas, with a brief account of plant named). Arch, Lond–April 3. 2200 w.

5366. Carbide of Calcium—Acetylene Gas (The present status of the manufacture, patents and literature on the subject. This is a most thorough and valuable report of a commission of able experts sent by *Progressive Age* to Spray, N. C., for the purpose of making full, accurate, and impartial tests of the cost of carbide of calcium, in the interest solely of scientific truth. The report covers the following topics, viz.: past history; mode of production; synthetical possibilities; the flame temperature controversy; acetylene for power; acetylene as an illuminant; and liquified acetylene. It is accompanied by personal sketches of the *Progressive Age* commissioners (with portraits) substantiating their fitness for conducting such an investigation; a list of American and foreign patents for production of calcium-carbide and production and distribution of acetylene gas, and an exhaustive bibliography of the subject. The descriptive part is illustrated with engravings. Never before has so complete an exposition of the whole subject been made). Pro Age–April 15 12500 w.

5368. Æenrichment of Purifying Materials and the Value of Spent Material. F. Auerbach (The aim of this article is to call the attention of

We supply copies of these articles. See introductory.

gas-works to the considerable value their spent material may attain, by the exercise of greater care in selection of fresh material in condensation and in washing). Pro Age-April 15. 1500 w.

5464. Cheap Gas and Coke for Boston and Suburbs (Digest of the testimony of H. M. Whitney before the Legislative Committee on Manufactures, giving description of the process of coking, utilization of residues, and gas statistics of Massachusetts and Great Britain). Sci Am Sup-April 18. 2200 w.

*5497. The Carbide-Acetylene Patents (Interview with Prof. Lewes. Notwithstanding the action of the British House of Lords in rejecting the Willson bill, Prof. Lewes thinks the electrical furnace patents, and not the Bullier or Willson patents, will be the governing factor in the production of calcium carbide, and that this manufacture will not be open to the public till the electrical furnace patents lapse. He also has much to say with reference to practical points regarding the safe and efficient use of acetylene in illumination, and this is the most valuable feature of the reported interview). Gas Wld-April 11. 2500 w.

*5501. The Recovery of Tar and Ammonia from Blast-Furnace Gases. A. Gillespie (Read at meeting of the Inst. of Engineers and Shipbuilders in Scotland. Subject treated in the main as a practical question of economy in the manufacture, with a review of processes available for the purpose). Jour Gas Lgt-April 7. 3000 w.

5571. The Fire Hazard of Acetylene (Present attitude of fire underwriters toward the employment of acetylene. The liability to explosions is considered as a special fire hazard, etc. Abstract of an article in *Am. Exch. and Review*). Am Gas Lgt Jour-April 27. 600 w.

5759. On the Nitrogen and Nitrogenous Products of Coal. Dr. Knublauch (Paper read before the German Gas Assn. A record of several years experiments at the Cologne gas-works, and in the author's own laboratory). Pro Age-May 1. 1000 w.

Sewerage.

5328. Sewer Intersections at Baltimore, Md. Charles P. Kahler (Description with explanatory diagrams of the chamber or conical section as employed in Baltimore. Also accompanied photographs reproduced in half-tone). Eng News-April 9. 350 w.

5534. The Natick, Mass., Sewage Reservoirs (Very complete illustrated detailed description). Eng Rec-April 25. 1800 w.

5536. Winchester, Mass., Sewer Details (Illustrated detailed description, also comprising the methods employed by the sewer committee in using help resident in the town, and the method of proceeding whereby applicants obtain house connections). Eng Rec-April 25. 1100 w.

5626. Maintenance of a Separate System of Sewers. T. Harry Jones (Paper relates to sewers in Brantford, Ont. These sewers were built and are now maintained by the city with day labor. Full account of the system is given, and, also details of practice in flushing). Eng News-April 23. 900 w.

*5637. The Sewerage System of Indianapolis. Charles Carroll Brown (An excellent, comprehensive detailed illustrated description of an interesting example of sewer work). Jour Assn of Eng Soc-March. 7000 w.

5920. A Small Sewage Disposal Plant (General description of plant, with plans at the Rockingham County farm, New Hampshire). Eng Rec-May 9. 450 w.

Streets and Pavements.

5331. Tests of Paving Brick at Williamsport (Results of abrasion and absorption tests on fifteen kinds of paving brick submitted with bids at Williamsport, Pa). Eng News-April 9. Table.

*5400. Paving Bricks. F. Paul Anderson (The results of a large number of tests made on fire clay brick and paving brick, giving deductions, precautions, method of testing and numerous half tone illustrations of crushed specimens). Digest of Phys Tests-April. 3000 w.

5746. Brick Street Paving in Jackson, Mich. (Illustrated description of methods employed in repaving a street 68 ft wide between curbs, and 99 ft. wide between property lines, in Jackson, Mich., and which had been previously paved with McAdam thoroughly compacted by long use). Eng News-April 30. 1300 w.

*5784. The Pavements of an Australian City. F. A. Campbell (Illustrated general description). Pav & Mun Engng-May. 1000 w.

Water Supply.

5291. Toledo, O., Water Works (Illustrated detailed description. The department is said not only to pay its own way, but also to make large profits). Fire & Water-April 11. 1700 w.

5385. The Providence Filtration Experiments (Reprinted from Appendix to the Annual Report of the Rhode Island State Board of Health. The experiments were under the direction of the city engineer, J. Herbert Shedd, and occupied a period of nearly one year. Results and data are given). Eng Rec-April 11. 2800 w.

†5408. Delhi Water Works Scheme. B. Parkes (Review of a report submitted to the Delhi (India) Municipal committee, in which it is proposed, under peculiar and interesting conditions to obtain a supply for the city from a group of 211 connecting wells. A map of the district and of the city accompanies the report). Ind Engng-March 7. Serial. 1st part. 1700 w.

*5477. The Water Supply of the Paris Suburbs (Illustrated general description). Eng, Lond-April 3. 700 w.

5484. The Lowell, Mass., Water Works (Describes and illustrates a notable increase in the driven well system of this city already noted for its driven-well system and its filtration methods). Fire & Water-April 18. 700 w.

5526. Salem, Mass., Water Works (Illustrated description. The first part deals principally with installations, costs, and capacities. It is illustrated with portraits of the Salem

water board, the building at the pumping station, the Worthington engine—in use since 1868—and a view of Lake Wenham, whence supply is derived). Fire & Water–April 25. Serial. 1st part. 700 w.

5527. Mechanical Filtration (Results of experiments performed by Mr. Edmund B. Weston, assistant city engineer in charge of Providence (R. I.) water department. The results of comparison between natural and mechanical filtration are decidedly favorable to the latter. A variety of filtration appliances were tested). Fire & Water–April 25. 2000 w.

5535. The Friction in Several Pumping Mains. Freeman C. Coffin (Paper read before the New England Water-Works Assn. Results of experiments made upon pumping mains in different cities, with tabulated data). Eng Rec–April 25. 2200 w.

5634.—$1.50. The Astoria City Water-Works. Arthur L. Adams (An instructive and interesting detailed, illustrated description, accompanied by cost tables). Trans Am Soc of Civ Eng–April. 17000 w.

*5668. The Water Supply of Small Towns and Rural Districts. Ill. Percy Griffith (Paper read before the Society of Engineers. The writer has for eight or ten years been associated with the design and construction of such works and is convinced that a study may be made of them with advantage. The paper deals with works supplying a maximum population of 10,000, and shows points in which both theory and practice as applied to large undertakings are quite distinct from those applicable to small ones). Ind & Ir–April 17. Serial. 1st part. 3000 w.

5748. Bacteriological and Chemical Studies of Public Water Supplies (An argument supporting the proposition that while both the chemist and bacteriologist are necessary to determine the character of potable water, too much reliance upon reports of bacteriologists alone may mislead the public, and stating conditions under which the services of both are required). Eng News–April 30. 1500 w.

†5782. The Filtration of City Water Supplies, with Special Reference to the Needs of the City of Philadelphia (An argument for the filtration of water drawn from the Schuylkill River fo, domestic supplv, by Edwin F. Smith ; with disr cussion by A. K. Leeds, L. Y. Schermerhorn, I. C. Trautwine, and others). Jour Fr Inst–May. 6000 w.

5835. Comparison of the Original Computations and the Actual Gaugings of the New Steel Conduit of the Rochester, N. Y., Water-Works (The data for comparison were found by very careful gaugings at different points, and a curious set of conclusions for the case of a riveted steel pipe, made of alternate inside and outside courses, is illustrated diagrammatically. From these data formulæ for the constriction, for the enlargement, and for the total loss of head in such pipes are deduced). Eng Rec–May 2. 3500 w.

†5891. The Queen Lane Division of the Water Works of Philadelphia (Part I. The Boilers, by John E. Codman, gives an illustrated description of the boiler installment. Part II. The Pumping Engines, by Thomas H. Mirkil, Jr., and Part III. The Engine and Boiler Houses, by F. L. Hand are illustrated, described and discussed). Pro Eng's Club of Phila–April. 2800 w.

5914. The Specifications for a New Water Supply for Jersey City. C. C. Vermeule (Reply to an editorial criticism in issue of Eng. News (April 30) on report of Engineer C. C. Vermeule, relating to the proposed Jersey City water supply, and an answer to the communication, by the editor of the named journal). Eng News–May 7. 2800 w.

5919. The Ottumwa, Iowa, Filters (General description of plant). Eng Rec–May 9. 600 w.

Miscellany.

*5286. Some Practical Ideas on Steam Disinfecting Apparatus (The subject is discussed both theoretically and practically. A description is also given of an apparatus, cheaply constructed and considered adapted to the service of health boards in municipalities). San Rec–April 3. 1700 w.

5367. Candle Power and Luminosity. W. H. Birchmore (The prevalent confusion of mind upon these subjects is attributed first to the neglect of proper consideration of the objects for which artificial light is used, and second, to the use, or rather the abuse, of the Bunsen photometer, an apparatus now used for a purpose of which its inventor never dreamed, and against which use, were he now alive, he would probably protest most loudly. From these standpoints the article proceeds to discuss the Bunsen photometer, and to show that, it measures emissive power only, and that it is not at all adapted to the comparison of high temperature lights such as have latterly come into use). Pro Age–April 15. 4000 w.

*5785. The Chemical Relations of Asphaltum. S. F. Peckham (A résumé of work done in this field up to date, and an indication of the lines upon which future chemical investigation should be directed). Pav & Mun Engng–May. 1500 w.

*5786. A Rapid Method of Apportioning Cost of Private Street Works. Thomas Caink (A simple method with the use of an instrument devised by the writer, whereby the computation of cost of street improvements to be charged abutting owners, can be made with practically no calculation and in a fraction of the time needed in the ordinary methods). Pav & Mun Engng–May. 600 w.

*5810. The Judgments in the Incandescent Gas Light Trials (The full text of the judgments is given with editorial comment. These judgments are a complete compendium of the facts as presented in the evidence in this famous litigation). Gas Wld–April 25. 16000 w.

5918. The Value of Water Power (Editorial, dealing with the general and special conditions and circumstances that should be considered in the condemnation of water supplies for municipal purposes). Eng Rec–May 9. 1200 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

The Future for American Railroaders.

PRESIDENT HAINES'S address before the American Railway Association at the Cincinnati meeting is notable for the excellent and timely review which he makes of the possibilities open to American enterprise, or, to put it more strongly and accurately, the necessities which will soon be incumbent upon it.

After summing up the valuable results already secured through the association in standardizing time, train-rules, car-couplers, grab irons, etc., Col. Haines proceeds:

"And the congress suggests another field of usefulness for the American Railway Association, — the introduction of American railway methods of construction and equipment and operation on that tripartite continent of which Europe is the smallest member. Of that continent of thirty-three million square miles Europe constitutes but one-ninth in area, and yet Europe is larger than the United States. Of the total railway mileage of the world nearly one-half is in this country, and most of the other half is in Europe. It is to the other great members of the transatlantic continent – it is to Asia and Africa—that I would draw your attention, with their area of nearly thirty million square miles and their population of one thousand million human beings. Is this great field for railroad construction and management to be disregarded by those who are wont to boast of American energy and enterprise? Are we to remain contented with the restricted possibilities for American railway men and for American manufacturers of railway material in the maintenance and operation of roads within our own national boundaries? We are approaching gradually to the conditions which prevail in Europe, where there are more men and larger productive plants than can be profitably employed at home, and we must look abroad for their employment. But it would be a waste of time to seek for opportunities in Europe." "Indeed, Great Britain and the western European States themselves now look abroad for profitable employment for their men, their manufacturers, and their surplus capital. Great Britain has found her field in her own colonies. France has hers in Africa, in Algeria, and Senegal. Belgium has established hers in equatorial Africa, and the Germans, just now outgrowing in productiveness their own needs, are eagerly watching and imitating their British kinfolks. Austria-Hungary, with half our population, is stretching her rails and her trade down the Danube and into the Balkan peninsula.

"In considering this general advance of European countries all along the strategetic line of this campaign for African and Asiatic trade, we may well ask, what will be left for the United States? On the north of us is Canada, British by sentiment, and but partly American in railroad practice. To the south of us is Mexico, where we have some advantage over European methods and appliances; some little opportunity in Cuba and Jamaica, and more perhaps in Central America. Then comes South America, with nearly twice our area and half our population. This is our sphere of action, or, at least, that which will be left to us, if we close our eyes to what is going on elsewhere on the globe. If we wait until fifty miles is built from one African seaport and twenty from another into the heart of that continent, all under the British system, we may say farewell for employment thereafter for any American men in those regions, or for the sale of railway appliances of American make. If French or Belgian or German engineers lay out a railroad line anywhere on the habitable globe, the French or Belgian or German appliances follow, as surely as the thread follows the needle."

"American methods are best suited for

opening up routes on which the traffic has yet to be created. Whatever is best in European practice is best adapted to routes which are intended to furnish facilities for existing traffic. . . . It is not our first-class roads that the projectors in those untried fields can study to advantage. It is the cheap road, the cheap methods of operation, that their interests require, and of which they are ignorant. . . . And it is just here that the value of the American Railway Association comes in,—that is, in pointing out the way for penetrating this ignorance, for dispersing the clouds of prejudice and the fog of indifference which obscure the minds of those European engineers who control the purse-strings of the European capitalists that are to provide the means for constructing the untold thousands and tens of thousands of miles of railroad yet to be built in Asia and Africa and elsewhere, outside of the present limits of American influence. But we must teach by example. Instead of addressing the seven or eight hundred railway engineers and managers that make up the international congress, in a land where there is not one example of American practice, let us induce that great body of men, foremost in railway reputation and experience throughout the world, to come and listen to us here, where every word that we speak will be multiplied in effect one-thousand-fold by what they will find all around them. It is a case in which a great result is to be sought, one of momentous importance to the future welfare of our people, and the effort to accomplish this result must be correspondingly great. Desultory, isolated attempts will fail. Our energies must be concentrated to be effective, and the most effective way to concentrate them can only be afforded by the American Railway Association."

The Question of Cheap Carfare.

UNDER the caption, "Three-Cent Fare Fallacy Exposed," the *Street Railway Review* publishes what the writer styles "an absolutely convincing argument," the "argument" being the subjoined table compiled by the Massachusetts railroad commission.

The *Review* article closes with the statement that "the table explains itself, and constitutes a simply irrefutable argument why a three-cent fare is not only impracticable, but impossible."

	Operating Expenses per Passenger.	Operating Expenses per Car Mile.	Receipts per Car Mile.
Athol and Orange	.0310	1338	.2181
Braintree	.0762	2197	.1410
Braintree and Weymouth	.0289	.0659	.1131
Brockton	.0264	1275	.2541
Clinton	.0493	.1624	.1659
Conway Electric	.1534	.2735	.2066
Cottage City	.0306	.1127	.2011
Dartmouth and Westport	.1400	2678	.3070
Dighton, Somerset and Swan ea	.0473	2091	.2865
East Wareham, Onset Bay and Pt. Ind	.1522	.6302	.5607
Fitchburg and Leominster	.0425	.1544	.2098
Framingham Union	.0305	.1080	.2104
Gardner Electric	.0431	.1912	.2215
Globe (Fall River)	.0300	1616	.2746
Gloucester	.0313	.1695	.2726
Gloucester, Essex and Beverly	.0356	.0088	.2509
Gloucester and Rockport	.0309	.3182	.4477
Greenfield and Turner's Falls	.0210	.1761	.2718
Haverhill and Amesbury	.0454	1732	.2754
Holyoke	.0337	.1672	.2703
Hoosac Valley (North Adams)	.0409	.1751	.2357
Hull	.0567	.2206	.3566
Lowell, Lawrence and Haverhill	.0324	.1943	.2983
Lowell and Suburban	.0304	.1203	.2099
Lynn and Boston	.0363	.1603	.2814
Marlborough	.0300	.1201	.1824
Montague	.2241	.0798	.1903
Natick and Cochituate	.0326	.1669	.2644
Newburyport and Amesbury	.0316	.1258	.2004
Newton	.0338	.1720	.2184
Newton and Boston	.0309	.1308	.1777
Newtonville and Watertown	.0385	.1473	.1692
Norfolk Suburban (Hyde Park, etc.)	.0284	.1538	.2161
Northampton	.0282	.1167	.2108
North End (Worcester)	.0530	.1478	.1323
North Woburn	.0459	.1866	.2121
Pittsfield Electric	.0366	.1675	.2804
Plymouth and Kingston	.0377	.1493	.2201
Quincy and Boston	.0260	.1035	.2852
Rockland and Abington	.0760	.1541	.2093
South Middlesex (Natick)	.0347	.1043	.2297
Springfield	.0330	.1538	.2453
Taunton	.0287	.1312	.2085
Union (New Bedford)	.0284	.1004	.2043
Wakefield and Stoneham	.0315	.1247	.1961
West End (Boston)	.0353	.2539	.3492
Worcester Consolidated	.0368	.1851	.2512
Worcester and Suburban	.0314	.1390	.2716
Woronoco (Westfield)	.0508	.1539	.1534
Average	.0349	.2082	.3020

It is, however, hard to see how the table can be construed as irrefutably showing anything, except that for the year ending September 30, 1895, it did cost the roads, *on the average*, more than three cents per passenger for operating expenses. There were exceptions, and notable ones. The *Review* weakens their force by stating that, "of the fifty roads, only nine show a transportation cost of less than three cents." To be more exact, of the forty-nine roads, ten show a lower cost; the *Review* writer for some reason overlooks Greenfield and Turner's Falls, .0210, the lowest road reporting. On the other hand, no attention is directed to the enormous and evidently abnormal figures of Braintree, .0762; Conway Electric, .1534; Dartmouth and West-

port, .1400; and East Wareham, .1522,—which, of course, tend to unduly elevate the average. A stronger point is made in the statement that, if interest and taxes be included (the writer says they are not in the tabulated figures), no road except the Montague (and perhaps the Greenfield and Turner's Falls?) would show transportation expenses below three cents per passenger.

The *Review* writer sees no way of meeting the lower fares, except through lowered expense secured by reduction of wages. He does not even touch upon the main question, which is: would the lower fare attract such an increased volume of business that the reduction would be more than offset and the gross earnings augmented, while the operating expenses would not be appreciably increased?

For this business is like any other: up to a certain point all of the receipts must go towards operating expenses; after the point of balance is passed, nearly the entire remaining receipts go to dividends and profits. If, under the lower fares, two passengers would ride where one is now carried, or the average passenger would ride twice a day where he now rides once, the road would receive six cents for every five now gathered in,—an increase of twenty per cent. in earnings.

It is extremely doubtful if the increase of expense would be even ten per cent. If not, the road would be the gainer by the change.

The *Review* writer is correct in considering the conditions surrounding the Massachusetts roads "ideal for street-railroading," situated, as they are, in the midst of a dense manufacturing population.

It is, however, debatable whether or not these people "*must* use the cars night and morning" on their way to and from work. The alternative is not, as he suggests, "to keep a horse and vehicle of their own," or to "patronize livery stables to any extent," but simply—to walk.

They *may* use the cars, it is true, and, if the thousands who walk would be induced to ride, and the thousands who ride would be induced to ride oftener, by the three-cent fare, it might be proved neither impossible or impracticable; indeed, it is not inconceivable that its adoption should be the wisest business policy.

The similar but proportionably larger reduction forced upon the New York elevated roads was just as "irrefutably" shown in advance to be "not only impracticable, but impossible"; everyone knows the enormous success with which they have since been operated. The wind is undoubtedly setting in the direction of lower fares, and the railroads will be wise to trim their sails in expectancy of it.

Brine Corrosion of Tracks and Bridges.

THE connection between dressed beef and the destruction of railway bridges seems, at the first glance, a little remote; and yet it is so obvious that the wonder is that it has not sooner excited the attention of railway men. It seems to have remained for the Central Railway Club to bring the matter to general notice by the discussion, at the March meeting, of a committee report upon "Injury Caused by Salt-Water Drippings." The drippings, of course, were from refrigerator cars, and the injury not only to the cars themselves, but to rails, frogs, switches, and bridges.

The startling feature seems to be the extent to which the corrosion has proceeded without any organized effort on the part of the roads to find relief.

The P.C.C. & St. L. notes the "destruction of iron surface cattle guards, and in pipe lines in interlocking switches where they cross tracks. Also annoyance from inability to tighten bolts on switches and frogs." On the N. Y. C. & St. L. Ry., "trouble has been noticed for some time. At points where trains stop regularly, such as terminals, water stations, etc., and whereever brakes are put on, so trains close up and the jar causes water to splash out, rails are found rusted and angle-bars and bolts are rusted 1-16 of an inch thick at joints in some cases. In one case a bridge floor was badly rusted."

The L. S. & M. S. Ry. find the "action of brine is very marked, particularly at points where trains stop and start. Outside splices at many points are badly rusted, and top floor beams and other iron

work in floors of bridges are suffering very, very much. . . . They find corrosion confined entirely to east-bound track, which is the one used entirely by the loaded refrigerator cars. Corrosion is found more particularly on lower rail on curves where trains run slowly or stop. . . . Rusted so badly on 1888 pattern of rail in places that base of splice bars is sharp. All bridges, on east-bound track require paint each year to preserve them, while on west-bound track paint on bridges lasts good for a number of years." According to the Lehigh Valley report, salt-drippings were in one case the "direct cause of a broken rail," and generally on the inside of the rail cause splices to "rust away so fast that they soon became too small for the rail, and can not be tightened even with new bolts." The Michigan Central finds the bad effect "notably on the cantilever bridge over the Niagara river," and in some switching yards has had "rails reduced in section from the action of brine."

Many roads concur in noticing aggravated action on the inner rail of curves and the floor beams of bridges; interlocking switch connections suffer severely, as might be expected.

The remedies adopted by the roads seem to be more vigilant inspection and cleaning of exposed structures, and more frequent and thorough painting. The Erie uses hot asphalt paint in the worst places, while the M. C. relies on graphite and the C. B. & Q. on "paint skins and sand put on ½ inch thick."

The Lehigh Valley recommends that "drainage be so arranged as to carry it entirely outside of the rails," and the P. C. C. & St. L. "that cars be arranged so as to prevent drippings"; but on the whole the roads seem strangely tolerant of the evil, and diffident about placing the onus on the owners and shippers of the cars.

The committee, however, is strongly inclined to require the dressed-beef companies to furnish the relief, and makes a recommendation, which it considers "perfectly practicable, for the drips in refrigerator cars to be connected with a reservoir or collector located near the center of car, or at each end over center of track, to hold drip until trains reach terminals or elsewhere, when reservoir can be emptied by trainmen or inspectors." They add minor details to meet the possible objections, and enforce the necessity of a radical change by citing recent wrecks due to the breakage of brake-beam hanger-eyes, rusted through by salt drippings.

Safety as well as economy would seem to demand that the railroads should prohibit the wholesale scattering of corrosive liquid along their permanent way, and the power, as well as the right, to enforce a remedy appears to rest in their own hands.

THE Orleans Railway, France, says *Engineering News*, reports great success in suppressing dust from sand-ballast by covering the roadbed with a 2½ inch bed of broken stone. It is said that the cost is one-fourth that of stone-ballasting, and that large saving to rolling-stock results from suppression of dust.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*5266. Are British Railroads Good Investments? Thomas F. Woodlock (Showing the ratio of capital to revenue and of operating expenses to earnings in the administration of British railroads, and maintaining that the decreasing percentage of dividend and the steady increase in operating expenses point to a decline of confidence in the security of British railroad shares). Eng Mag–May. 4700 w.

*5292. Snowdon Mountain Railway (A full description from the historic, descriptive and technical standpoints, with map, profile and eight fine half tones from photographs of scenery). Engng–April 3. Serial. 1st part. 3700 w.

*5297. Train Resistance. Angus Sinclair (The text-book formulæ impugned and evidence of their inaccuracy furnished. Incidentally the fast run on the L. S. & M. S. is defended against attacks based on theoretical calculations). Engng–April 3. 1500 w.

5299. Empty Car Mileage (Editorial review of A. E. Mitchell's paper before the New York R. R. Club on the "Large Car Problem"). R

We supply copies of these articles. See introductory.

R Car Jour–April. 500 w.

5300. Air Brake Hose Dummy Couplings (Editorial reviewing the defects of common practice and suggesting a remedy). R R Car Jour–April. 250 w.

5301. Air-Brake Testing and Inspecting Plant (Editorial review of the report of the Committee on Air-Brake Testing and Inspecting Plants. An extract is given embodying the recommendation as to inspection and testing in interchange yards and elsewhere). R R Car Jour–April. 500 w.

5302. Examination of Car Inspectors (A symposium of correspondence, chiefly commendatory). R R Car Jour–April. 1800 w.

5303. M. C. B. A. Arbitration Cases (A full tabulation of cases submitted, won and lost by the various roads and companies). R R Car Jour–April. 500 w.

5304. M. C. B. Association Standards and Recommendations (An abstract of the recent M. C. B. A. circular embodying suggestions received and recommendations adopted by the committee to date) R R Car Jour-April. 1000 w.

5305. Piece Work in Car Shops. G. L. Potter (A paper read before the Western Railway Club. A discussion of the application to repair work especially, the conclusion being strongly favorable to the system. The paper embodies illustrations of actual practice and of the forms in use in standard car shops). R R Car Jour–April. 2300 w.

5306. Combination Ore Car: Duluth, South Shore and Atlantic Ry. (Descriptive text and full drawings). R R Car Jour–April. 900 w.

5307. The Social Circle Decision (Editorial calling attention to the limited scope of the decision and the error into which the press generally has fallen in giving it too wide an interpretation). Ry Age–April 11. 1000 w.

5309. Employés on Government Railways.—The Rules and Regulations in Force on the Government Railways of Australia. Alfred C. Fraser (A brief introductory note commends the article to attention on account of its interest in connection with the agitation for government ownership of railways in this country). Ry Age–April 11. 3300 w.

5310. Electricity on Elevated Roads (The change from steam to electric power being made on the Lake street road in Chicago). Ry Age–April 11. 800 w.

*5311. Through the Baltimore Tunnel on an Electric Locomotive. Ill. A. M. B. (Describing the power plant, the general arrangement and practical working). Ry Wld–April. 1500 w.

*5312. Notes on Austrian and Italian Railways (The first paper contains detailed reports of single English and French runs, and general observations on fares, equipment and station accommodations in Austria. Passing mention is made of the steepest adhesion railway in Europe—that to the summit of the Uetliberg). Ry Wld–April. 1200 w.

*5313. Rouen Electric Tramways (Descriptive of the power installations, buildings, construction of the line, rolling-stock, cost of erection and rates of fare). Ry Wld–April. 2800 w.

*5314. Improved Tramcar Lighting (An English opinion of the New York situation, gleaned from the local press. Contains an interesting comment on the effect of good lighting upon volume of travel). Ry Wld–April. 250 w.

*5315. The Vulcan Foundry and its Early Engines. Clement E. Stretton (A list of early English engines, with partial measurements). Ry Wld–April. 800 w.

*5316. Storage Battery Traction at Birmingham (Described as being quite satisfactory to the public and very unprofitable to the companies). Ry Wld–April. 600 w.

*5317. Newspaper Comment on Electric Traction (Indicating the status of the overhead wire question in London). Ry Wld–April. 600 w.

*5318. The Stanzerhorn Cable Railway (Brief description of a steep inclined road). Ry Wld–April. 450 w.

5323. Profiles of the Principal Mountain Railways of the World (Chart superimposing European, South American and U. S. mountain lines, with brief explanatory comment). Eng News–April 9. 400 w.

†5334. Air Brake Testing and Inspecting Plants (Full report of Committee to the Central Railway Club). Pro Cent Ry Club–March. 2000 w.

†5335. Stenciled Light Weight of Cars (Central Railroad Club Committee's report and discussion of change in car weights, and means of checking). Pro Cent Ry Club–March. 4000 w.

†5336. Injury Caused by Salt Water Drippings (Rather startling report of injury to cars, track, bridges, etc., from the salt drippings from refrigerator cars). Pro Cent Ry Club–March. 3000 w.

†5337. Hot Boxes and Their Cause (Causes of hot boxes discussed, experiences compared and remedies proposed). Pro Cent Ry Club–March. 5000 w.

*5343. Electric Traction on Rack Railways. Frank B. Lea (The advantages are set forth, and several noted lines are briefly described). Elec Eng, Lond–April 3. 2000 w.

*5350. Light Railways: Their Advantages, Nature, and Working (An article on their importance, and quoting freely the statements made by Mr. Brewer). Ill Car & Build–April 3. 1100 w.

5357. Electricity on Trunk Railroads. William Baxter, Jr. (The writer thinks it has been fully demonstrated that electric motors are capable of handling the heaviest traffic, and if the saving in operating expenses should prove to be below that of steam, at least new roads would use electricity). Sci Am–April 18. 1200 w.

5373. Some of the Difficulties in Designing Rail Sections. P. H. Dudley (A letter from a well known expert in rail designing, describing the difficulty of designing a rail section so that it will roll well and will have the specified weight). R R Gaz–April 17. 800 w.

5374. Three-Position Signals and Permissive Blocking. J. W. T., Jr. (A word in defense of permissive blocking). R R Gaz-April 17. 400 w.

5375. The Uses of Momentum Grades. William G. Raymond (A letter discussing some of the features involved in the theory and practice of using the momentum of the train in surmounting grades). R R Gaz-April 17. 1100 w.

5376. 60,000-lb. Coal Car, Southern Railway (Detail drawings with dimensions). R R Gaz-April 17. 200 w.

5377. The World-Wide Field for American Railroad Men (Condensed address of Col. H. S. Haines, President of the American Railway Association, at Cincinnati, April 15, drawing attention to wide field for railroad work in Asia and Africa). R R Gaz-April 17. 1800 w.

5378. The Philadelphia and Reading Railroad Subway and Tunnel in Philadelphia. Walter Atlee (A brief description of the great project for separating the street grades and the grades of the Phila. & Read. R. R). R R Gaz-April 17. 900 w.

5379. Air-Brake Piston Travel (A report on the effects of air-brake piston travel and the limits which should be set to that travel. Made by a committee of the Air Brakemen's Asso). R R Gaz-April 17. 4000 w.

*5392. The North Wales and Liverpool Railway (An important link in the Welsh Railway system and a notable drawbridge). Trans-April 3. 2700 w.

*5394. The Railways of Rhodesia (A very brief note of the present conditions). Trans-April 3. 200 w.

5403. The Scranton Traction Company (Illustrated description of plant, buildings and equipment, including also the connecting Carbondale Traction Co.) Elec Ry Gaz-April 10. 1400 w.

5404. Maintenance of Rolling Stock. C. E. Ubelacker (Suggestions as to inspections, and repairs, with illustrations of tools and devices). Elec Ry Gaz-April 10. 2300 w.

5405. Cable vs. Electric Traction (Editorial argument for electric traction based on accidents due to the breakage of cable strands). Elec Ry Gaz-April 10. 300 w.

5406. The Street Railway Company Must Complete Its Contract (Summary of a decision affecting the rights of a passenger to transfer around a blockade without paying a second fare). Elec Ry Gaz-April 10. 300 w.

*5416. Pleasure Resort Roads (A list of the principal roads of this character, with brief description and illustrations of their attractions. The topic is treated with reference to its relation to travel and income). St Ry Rev-April 15. 3000 w.

*5417. Power House Performance (Tabulation of results of twenty plants, with comment on condensing engines and economy of condensing water). St Ry Rev-April 15. 800 w.

*5418. Conductorless Roads (A list of roads operated wholly or partly without conductors. Editorial comment calls attention to the smallness of the number and the generally poor economy of the practice). St Ry Rev-April 15. 900 w.

*5419. Counterweight System at Providence, R. I. M. H. Bronsdon (The application of the system to a difficult case is illustrated by plans, photographs, and explanatory text). St Ry Rev-April 15. 700 w.

*5420. Preservation of Wooden Posts (Stone ware cover suggested as a protection at the ground line for posts used for carrying electric wires, etc). St Ry Rev-April 15. 300 w.

*5421. Interurban Express at Binghamton, N. Y. J. P. E. Clark (Introduction of express and freight service on an electric road is described, with illustrations of the combination car employed). St Ry Rev-April 15. 1200 w.

*5422. A New Method of Testing Rail Bonds. Harold P. Brown (Description of a new method employed on the Niagara Gorge Road, with comment on the extremely satisfactory results determined). St Ry Rev-April 15. 600 w.

*5423. A German Substitute for Guard Wires (Illustrated description of a device which is recommended as securing entire efficiency with reduced cost). St Ry Rev-April 15. 600 w.

*5424. Earnings and Operating Expenses of Connecticut Street Railways (Detailed reports from twenty railways). St Ry Rev-April 15. 1300 w.

*5425. Lake Street Elevated Motor Cars and Shops (Brief description with photographs). St Ry Rev-April 15. 250 w.

*5426. Standard Electrical Rules Relating to Street Railways (This is a communication from Frank R. Ford, representing the American Street Railway Association, presenting the rules at present adopted and asking for suggestions as to revision). St Ry Rev-April 15. 1000 w.

*5427. Development of Electrical Traction Apparatus (A review of the American Field, abstracted from Mr. H. F. Parshall's paper before the Foreign and Colonial Section of the Society of Arts, in England. It contains some points of current interest and information to American electric railway men). St Ry Rev-April 15. 1200 w.

*5428. Three-Cent Fare Fallacy Exposed (A review of the report of the Mass. R. R. Commission, showing that on every road in the State the operating expenses exceed 3 cts. per passenger. The writer concludes that this demonstrates the impossibility of a 3 cts. fare). St Ry Rev-April 15. 1100 w.

*5429. Life of Rails under Electric Service (A compilation of reports from various roads). St Ry Rev-April 15. 1100 w.

5443. Demurrage Legislation (Full text of a bill introduced in the Ohio legislature designed to enforce demurrage charges against railroads as well as shippers and consignees). Ry Rev-April 18. 1000 w.

5444. Qualifications of a Superintendent of Air Brakes (A paper read by F. B. Farmer before the Northwest Railway Club. Prefacing

the author's estimate of qualifications by a summary of reasons demanding the existence of such an official enforced by instances from experience). Ry Rev–April 18. 1800 w.

5445. The Electro-Pneumatic Interlocking Plant at Grand Avenue, St. Louis (Description with plan of tracks and signals, cuts of the machine, sample charts of lever locking and dog-shed). Ry Rev–April 18. 2000 w.

5446. Transportation From an Operating Standpoint. D. S. Sutherland (Read at the meeting of the Toledo Asso. of R. R. Officers. Calling attention to the failure to effect, in yards and terminals any such improvement as has been made in every other department of R. R. service). Ry Rev–April 18. 800 w.

5447. Electrical Equipment — Mt. Holly Branch Pennsylvania R. R. Calvert Townley (Paper read before the New England R. R. Club, describing the partial application of electric traction to a road formerly wholly operated by steam). Ry Rev–April 18. 1000 w.

5448. Shop Notes Atchison, Topeka & Santa Fé Ry., Topeka, Kan. (Describing some interesting points of practice and economy in a practical and progressive shop). Ry Rev–April 18. 2800 w.

5453. The Influence of Braked Trains on the Superstructure of Metallic Bridges. F. Jasinski (Abstract of an article in the *Revue Generale des Chemins de Fer*, July, 1895, expressing the belief that strain from this cause is frequently overlooked, showing by example its importance, and suggesting a simple plan of resisting bracing). Ry Rev–April 11. 900 w.

5454. Track Elevation, N. Y., N. H., & H. R. R. in Boston (Data, drawings, diagrams, and general specifications of four track skew bridge). Ry Rev–April 11. 1200 w.

5455. Uniformity in Semaphore Signals (Editorial on a new rule adopted by the Pennsylvania Co., commending the practice). Ry Rev–April 11. 400 w.

5456. The Import Rate Case (Substance and major portion of U. S. Supreme Court opinion in the matter of through rates on freight shipped through a port of entry to an interior point, with editorial). Ry Rev–April 11. 10300 w.

5512. K. A. K. Conduit Electric Railway System (A system that has excited much attention in the west. It is a trolley conduit system and has a line of railway in operation in Springfield, O). W Elec–April 25. 800 w.

5515. A Ride on a Compound Locomotive and Other Matters. F. W. Dean (A communication devoted chiefly to comment on the relative value of fire-box and boiler-tube heating surface). R R Gaz–April 24. 600 w.

5517. The Air-Brake Men's Association (Full committee reports on the water raising system in sleeping-cars and the economical lubrication of air-brake cylinders). R R Gaz–April 24. 4800 w.

5518. Compound Switching Locomotive (Engravings and specifications, illustrative and descriptive of six-wheel connected compound locomotive for making up trains in the Grand Central Station at New York). R R Gaz–April 24. 1000 w.

5519. Brake Slack Adjusters (Committee report before the Air-Brakemen's Association, embodying the results of experience with adjusters, and recommendations as to construction, location, setting and general practice). R R Gaz–April 24. 1800 w.

5520. The Baltimore and Washington Electric Railroad (Brief description with sketch map of line and summary of progress made). R R Gaz–April 24. 1200 w.

5521. The Zone Tariff in Hungary (An editorial review of the proposed reform, giving the distance, fares, and a summary of the contemplated change which is expected to result in considerably increased revenue). R R Gaz–April 24. 500 w.

5522. A Free Cartage Decision (Review of an Inter-State Commerce Commission order prohibiting free cartage by the D., G. H., & M. railroad at Grand Rapids, and of a circuit court decision affirming the order, with an editorial discussion strongly urging the demoralizing influence of the practice). R R Gaz–April 24. 1400 w.

5523. Boiler Explosion at Bridgeport, Ala. (Brief illustrated account of an unexplained locomotive boiler explosion on the N., C., & St. L. Ry) R R Gaz–April 24. 150 w.

5524. Train Accidents in the United States in March (A summary of the accidents of the month with their causes and results). R R Gaz–April 24. 2300 w.

*5542. Some Recent Features of Permanent Way (Review and comment upon increased rail length trials and other recent experiments and innovations in practice, designed to increase the life of rails). Ir & Coal Trs Rev–April 10. 3200 w.

*5543. The Use of Iron and Steel for Railway Sleepers (A summary of the European situation, with some notes of current practice, and of results experienced. The conclusions drawn are non-committal, but inclined to be favorable). Ir & Coal Trs Rev–April 10. 1800 w.

*5544. The Construction and Supply of Rolling Stock (The article is almost entirely devoted to a discussion of the comparative merits of the English goods waggon and the American freight car, with the conclusion that each type is probably best suited to its own surrounding conditions). Ir & Coal Trs Rev–April 10. 1200 w.

*5545. Electric v. Steam Railways (A rambling mention of various features of American and European enterprise construction, with comparative tables of operating expenses on the Liverpool, Manhattan and Brooklyn Elevated roads in 1892 & 1893). Ir & Coal Trs Rev–April 10. 1600 w.

*5546. Railway Workshops and Their Equipment (An argument for the importance of having the best tools, and some suggestions for practical mechanical devices and handy appliances for shop use. The ideas are largely drawn from American practice). Ir & Coal Trs Rev–April 10. 2500 w.

SCIENTIFIC MISCELLANY

The Dudley "Powder-Pneumatic" Gun.

THE accident which occurred at the recent trial of this gun, in which a shell prematurely exploded, has, it is said, demonstrated no defect either in the principle or construction of the weapon. It has shown only the defective character of the type of fuse used for igniting the shells. As the method of obtaining a high pressure quickly in a considerable mass of air, which underlies the action of the gun, seems capable of extension to useful industrial purposes, we present here an abstract of the description given in the *Scientific American* (April 25).

Gunpowder, when burned behind a projectile in a gun, acts upon the projectile to move it forward exactly as steam acts upon a reciprocating piston, except that the inertia of the projectile, its friction in the gun-barrel, and external air pressure are the only elements of resistance in the gun, while in the steam cylinder there are added to these elements the friction and inertia of other moving parts at all times, and the mechanical work performed by the engine upon that which constitutes no part of its structure. The mere fact that far higher pressures are practicable in guns than in engine cylinders is a distinction of degree only; the main principle of action is precisely the same for both. The pressure of a confined gaseous body upon an inert mass is the immediate origin of power and of work performed by each.

In the steam engine the gas of water, produced under pressure in the boiler, is the immediate agent; in the ordinary gun, the gas produced by the powder is the immediate agent. In pneumatic guns, air compressed by some means (usually by a machine called an air-compressor) is what moves the projectile. In the Dudley "powder-pneumatic" gun, machine compression is avoided, and the compressed air is at once obtained by the explosion of gunpowder, thus dispensing entirely with the ponderous air-compressing machinery hitherto used, and adapting the gun to field-service.

Gunpowder has been previously used to generate power in mechanical operations other than the throwing of projectiles and the blasting of rocks. The gunpowder pile-driver has been, perhaps, the best known of these applications. But it is the particular method of gaining the store of compressed air in the Dudley system that is suggestive of applications in other fields. In the gunpowder pile-driver, and other attempts to utilize the gases of gunpowder as a source of mechanical power, no storing-up of power has been accomplished. In the method employed by Dudley, the compressed air may be held indefinitely for future use. The practical advantages of this feature of the invention will suggest themselves at once to all mechanics.

"Three tubes constitute the principal elements. These lie parallel to each other. A long central tube is the firing tube. The two side tubes are connected by an air passage at their forward ends, which ends are closed. The rear end of the left-hand tube, also closed, is connected to the rear end of the central barrel or firing tube. The right-hand tube and the firing tube have breech mechanism, like that of a breech-loading rifle.

"The action and manipulation of the piece is simplicity itself. A metallic powder cartridge is inserted into the rear end of the right-hand tube, and its breech is closed. A torpedo is placed in the central tube, whose breech is then closed. The powder is fired. The air in the tubes is compressed by the gases generated from the explosion, the pressure rising to eight hundred and fifty pounds. The force of the explosion, cushioned by the two columns of air intervening between the powder and the projectile in the central tube, acts upon the projectile. With a slight noise and without a particle of smoke or flame the projectile is driven out of the barrel and passes smoothly through its

trajectory. About the same effect is attained as with the regular pneumatic gun. The extensive air-compressing plant of the latter is, in the case of the Dudley gun, represented by a simple blank cartridge."

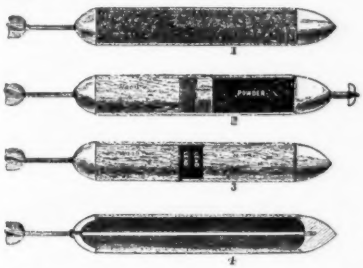
The safety attachment to the Merriam fuse used with the projectiles is a very ingenious device. The figures illustrating projectiles, herewith reproduced, are almost self-explanatory.

"The Merriam fuse operates by inertia or by direct impact. If the shell strikes the water, the inertia operates the ignition. A steel ball within it is driven forward, owing to the retardation of the motion; and the ball, by striking, causes the detonation of one or more percussion caps, three being used to insure firing. The ignition of a tube of slow-burning powder is thus effected, which communicates with the fulminating mercury and so explodes successively the gun-cotton and the main explosive in the shell. The period of the explosion is determined by the slow-burning powder; by altering it, the time element can be regulated with the greatest accuracy.

"For attack upon armor, instant detonation is required, and this is secured on the direct-impact principle, by crushing in of the head, and the driving back of one to three firing pins, which ignite quick-burning powder, the fulminate, the gun cotton, and the main explosive in instantaneous succession.

"The element of safety is introduced in the Merriam fuse by a little windmill, or vane, on the front of the fuse. This is inclosed in a recess, whence it escapes as the shell leaves the gun, and instantly begins to turn, actuating a screw which has been screwed down upon the firing ball. After the shell has traveled a few hundred feet, the ball is free to work the instant the shell is arrested in its flight.

"Fig. 1 shows the service shell packed with high explosive, the fuse vane being concealed within the forward cone. The rear cone is of aluminum. Fig. 2 shows a practice cone charged with gunpowder, lead ballasted, and with the fuse vane shown projecting from its forward end. It was with a shell of this type that the accident occurred. Figs. 3 and 4 are simple non explosive practice shells, one of wood, the other of metal. The ballasting of the projectiles is of the greatest importance, as their steadiness of flight depends on the center of gravity being in a definite place."



The gun weighs about a ton, including the mount, and, it is said, is capable of throwing shells weighing thirty-two pounds, with an initial velocity of seven hundred feet per second. The recoil is very slight.

Steel Tanks for Storing Grain.

THE preservation of food products (of which wheat is by far the most important to the human race, taken as a whole) is a matter of prime importance. In some less-favored countries years of what would be utter famine are bridged over by provident wisdom in this way. Jnanendra Narayan Ghose, in *The Arena* for May, speaks of the famines that have occurred in India, and tells us that, when Mysore was under British rule, neglect of English officials to provide a store of water for irrigation in the years 1876-77-78, when the seasonal rains failed, caused one-fourth of the native population to perish from scarcity of food. This, he further says, was the result of pure neglect, "for so complete and admirable is the tank system of Mysore that famine is impossible," if proper care be exercised. What he thus calls tanks we should call reservoirs, and they are very numerous in Mysore. There are, according to this writer, thirty-eight thousand of them, varying in size from small ponds to extensive lakes. In the years above stated many of these had been allowed to become almost useless through neglect. It is thus

seen that emergencies may arise when stores of food become of much more than ordinary importance, and even in favored lands such stores are needful to insure the proper preservation and distribution of food to the people. Anything that favors these desirable ends is a boon to the human race, and also to the large animal dependency which is under the care of, and receives its sustenance from, the hand of man.

The steel-tank system of grain storage appears to combine all essentials for the preservation of cereals for indefinite periods. Injury by fire, moisture, or vermin seems completely provided against, and the lateral pressure, analogous to hydrostatic pressure, in a deep mass of grain is most completely restrained by the cylindrical form, so that very large masses of well-cured grain may be stored on a small area of ground,—an important consideration in large cities, where land is very valuable.

American Miller (May 1) publishes an illustrated description of some steel tanks erected at the Manhattan Mill at Toledo, Ohio, which are used in connection with the so-called "pneumatic system" of conveying grain, by which the grain is cooled and either delivered into the storage tanks (which loom up much like large gas-holders) or taken from the tanks into the bins of the mill, as desired for milling.

"The pneumatic machinery is located on the fourth floor of the mill building, the grain being conveyed to this point by an ordinary elevator, from which it is spouted into an air-tight steel receiver, to which one of the P. H. & F. M. Roots Co.'s positive blowers is connected by an air pipe on the dome. Power is transmitted by two belts direct to the blower. Upon entering this receiver, the grain drops of its own weight to the bottom, from which it is fed through an automatic feed device into the blast current, which carries it from the mill to the tanks, entering them at the top.

"In bringing grain from the tanks to the mill the current is changed by manipulating two valves, from that of a blast to a suction, closing a valve on top of the tanks and opening one on a pipe leading down between them, at the end of which is a peculiar shaped mouthpiece, resting on the bottom of a metal sink. The air is admitted at this point by opening the outlet slides on the bottom of the tanks, and the grain rushes into the sink, where it comes in contact with a strong suction current. The ascending column, on leaving the chamber of the mouthpiece, assumes the rotating motion, and the grain is carried up in the direction of a winding inclined plane, similar to that observed in the whirlwind. As the grain enters the receiver, it drops by its own gravity to the bottom of the receiver, and again it is fed through the automatic feed device, from which it is spouted into the mill bins. The simplicity of the machinery is such that little or no attention is given it while in operation."

The extreme vertical lift is fifty-five feet. The horizontal pull is two hundred and fifty feet. An engine of about twelve horse power is said to be sufficient for handling the grain rapidly. The capacity of each of three tanks erected for the mill above named is twenty thousand bushels. This method of storing and handling grain bids fair to go into very extensive use.

A Well-Won Honor.

"DR. WM. H. WAHL, for many years resident secretary of the Franklin Institute, has been honored by the French government by election as 'Officier d'Académie,' with the decoration of the 'palmes académiques,' in recognition of his labors as secretary of the leading institute in America devoted to the advancement of the arts and manufactures, and of services rendered to the French government." Those who have the honor of a personal acquaintance with Dr. Wahl, and those who know the influence he has exerted upon scientific and material progress, will accord with us in the opinion that this high honor has been well-merited and worthily bestowed.

IN an article entitled "Comparative Merits of American and Foreign Cements" *Engineering News* (May 7) shows conclusively that no nation has the mo-

nopoly of manufacturing good cement, notwithstanding what it cails "the superstition concerning cement among engineers"; and "that the reputable brands of cement appear to be of about the same quality in one country as in another."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

*5263. Quackery in Engineering Education. Edgar Kidwell (Showing the falsity of the claims and the inadequacy of the methods by which technical schools and professors secure and train students). Eng Mag–May. 3700 w.

5272. Diffusive Reflection of Röntgen Rays. M. I. Pupin (Presented before the New York Academy of Sciences. A brief description of a series of experiments with Röntgen radiance which were recently conducted. The most important results refer to diffuse reflection or scattering of Röntgen radiance). Science–April 10. 3500 w.

5273. How Nature Regulates the Rains. R. L. Fulton (A discussion of the question of the relation of plant life to water supply. The building of railroads and opening of mines in the west, thus destroying the forests, have led to the conclusion that nature has storage facilities capable of resisting all that man may, or may not, do. An interesting paper). Science–April 10. 4500 w.

†5277. The Mushroom Industry in France (Description of the cultivation of mushrooms, as conducted in various parts of France, and of the different modes of packing and preserving them for market. It is estimated that a capital of 40,000,000 francs is invested in this industry in Paris alone). Consular Reports–March. 7800 w.

†5278. Cotton Mills of Japan (Statistics, giving number and names of mills and the quantity and value of their output in 1892, with reference to the development of cotton manufacturing in the far east). Consular Reports–March. 1000 w.

†5279. Belgian Damascus Gun Barrels (Description of the processes of manufacture, and statement of the magnitude and importance of the industry). Consular Reports–March. 1500 w.

*5344. The New Process for the Liquefaction of Air and Other Gases (Descriptive of a new apparatus, and its use. The results attained are of high scientific interest). Nature–April 2. 1000 w.

5353. Are Roentgen Ray Phenomena Due to Sound Waves? William A. Anthony, with Editorial and brief article by Thomas A. Edison (Mr. Anthony does not favor Mr. Edison's idea that the Röntgen ray may be sound waves. The editorial reviews the theories thus far advanced). Elec Eng–April 15. 1800 w.

5354. Producing Röntgen Rays Under Novel Conditions. E. W. Rice, Jr. (Interesting experiments made by the writer). Elec Wld–April 18. 900 w.

5355. The Source of the Röntgen Rays. Clarence I. Cory, J. N. Le Conte and R. W. Lohman (These experimenters conclude that the source of the Röntgen rays is the solid upon which the cathode rays first strike, giving up either partially or entirely their negative charge). Elec Wld–April 18. 2200 w.

5358. Magnetographs Made by Radiations from the Poles of a Magnet. John S. McKay (Experimental indications that the Röntgen effects may be due to the magnetic component of a Hertz wave, suggesting also that the Röntgen rays may themselves be something analogous to these magnetic rays). Sci Am–April 18. 800 w.

5362. Proposed Standard Tube for Producing Roentgen Rays. Elihu Thomson (Illustrated description). Elec Rev–April 15. 500 w.

*5369 Röntgen Rays. Max Osterberg (Paper prepared from a lecture delivered by the author before the N. Y. Electrical Society. It is accompanied by portraits of Faraday, Hertz, Crookes, and Röntgen). Elec Pow April. 5000 w.

5380. The Flow of the Connecticut River. Dwight Porter (Read before the American Forestry Association. Observations taken at Hartford and Holyoke are examined for the purpose of seeing whether they reveal any changes in the character of the flow which could be ascribed to the cutting of the forests. The writer finds no permanent change). Science–April. 1000 w.

5382 On the Best Shape for the Röntgen Ray Tube. W. M. Stine (A short discussion of tube designs with an illustration of the one the writer has adopted as a standard). W Elec–April 18. 600 w.

*5435. The X-Radiation: Interview with Mr. Jackson (Some account of the work accomplished by this experimenter). Elec Rev, Lond –April 10. 2000 w.

*5437. Further Progress in Radiography. Oliver Lodge (An interesting review of experiments, both in their application to surgery and anatomy, and in determining the physical nature of the rays). Elect'n–April 10. 3700 w.

5485. Roentgen Ray Diffusion and Opalescence—A Novel Phenomenon. Elihu Thomson (Describes the phenomena of diffusion of Roentgen rays by certain classes of substances in such a way that such substances must be regarded as opalescent). Elec Rev–April 22. 900 w.

5486. Tesla's Latest Roentgen Ray Investigations (A communication from Nikola Tesla giving an interesting account of his scientific work in this field). Elec Rev–April 22. 4500 w.

5495. Kinematics of the Roentgen Ray. W. M. Stine (Discussing refraction, reflection, difraction, and interference). Elec Eng–April 22. 1300 w.

We supply copies of these articles. See introductory.

5496. Influence of Temperature on X-Ray Effects. Thomas A. Edison (Experiments made by writer). Elec Eng–April 22. 500 w.

*5499. Pyrometers, and Their Application (Notes of an address by Dr. Mohlke to the Polytechnic Society of Berlin Treats of pyrometers based upon expansion by heat, of those based upon expansion by liquids, such as are based upon expansion of gases, those giving indications by radiation of light, of electrical methods, and calorimetric methods of determining high temperatures, and of definite temperature methods. It is compiled from information collected by the Imperial Physical Technical Institute, and relates to methods in use in German industrial arts). Gas Wld–April 12. 1300 w.

5500. The Dudley Powder Pneumatic Gun (An excellent, clear, detailed and illustrated description of the construction and use of this new weapon). Sci Am–April 25. 1400 w.

5513. Notes on Röntgen Rays. H. A. Rowland, N. R. Carmichael, and L. J. Briggs (A communication somewhat modifying their statement is published in the *American Journal of Science*, with account of further study in this field). Elec Wld–April 25. 1000 w.

*5557. The Electro-Chemical Company's Works at St. Helens (Illustrated general description of works, apparatus and process for resolving, by the electric current, common salt into soda and chlorine gas). Eng, Lond–April 10. 2000 w.

*5587. The Roentgen Rays. Henry Morton (States facts long known which in some cases seem to have been forgotten, and points out the true characteristics of Roentgen's discovery). Engng–April 17 2800 w.

*5588. The Metric System (A sharp criticism upon articles in the *Times* (London), charging that paper with criticising the decimal system, which, it is claimed, is by no means the same as the metric system. The decimal system is regarded as a mere incident of the metric system, since the meter might have been divided into eighths or twelfths, as well as into tenths. The duodecimal system is considered as more convenient than the decimal system, but in spite of some inconveniences the decimal system prevails, and there has never been any serious intention of altering it). Engng–April 17. 2500 w.

5640. The Use of the Röntgen X Rays in Surgery. W. W. Keen (An illustrated description of the method of investigation, with a statement of the difficulties and cautions against too hasty conclusions, closing with a summary of conclusions as to the present value of the method). McClure's Mag–May. 5000 w.

*5647. Suggestions for a Duodecimal System of Notation, Weights and Measures. G. Halliday (An article condemning the metric system, and suggesting the use of 12 as a base for a system and endeavoring to show that no very radical change is necessary for the adoption of such a system). Elec Eng, Lond–April 17. 2800 w.

5682. Apparatus for Measuring the Speed of Projectiles (Illustrated description of an instrument designed to measure very minute intervals of time developed at the United States Artillery School and used for measuring the velocity of projectiles from the new 3 2 inch B. L. field rifle adopted by the army). Sci Am–May 2. 1300 w.

5683. The Royal Observatory and How They Tell the Time at Greenwich (Illustrated description of a world famed observatory, and methods by which "Greenwich time" is determined). Sci Am–May 2. 1600 w.

5684. Bacteria In Milk. By H. W. Conn, of the Biological Department Wesleyan University, in the *Spatula* (The effects of bacteria in milk, as related to cleanliness in the procuring of milk from cows, and in the care bestowed upon it subsequently). Sci Am–May 2. 1800 w.

*5689. Photographing the Unseen—A Symposium on the Roentgen Rays. Ill. (The contributors to this symposium are Thomas C. Martin, Editor of the Electrical Engineer; R. W. Wood, Berlin, Germany; Elihu Thomson, Lynn, Mass; Sylvanus P. Thompson, London, Eng; J. C. McLennan, Univ. of Toronto; William J. Morton, New York, and Thomas A. Edison, all noted as able electricians, and some of them of world wide fame as physicists. What they have to say of the past, present and probable future of this new field is of great interest). Century Mag–May. 6000 w.

*5697. Professor Roentgen's Discovery and the Invisible World Around Us. James T. Bixby (A broad general discussion of this discovery in its relations to the already explored, and the yet unexplored, fields of science). Arena–May. 6800 w.

*5727. The Life History of an Ocean Wave. W. F. Durand (A study of the question how wind acting upon water gives rise to waves, a question never yet satisfactorily answered in detail). Sib Jour of Engng–April. 2200 w.

†5744. Röntgen Rays not Present in Sunlight. M. Carey Lea (Describes experiments which appear to demonstrate that, contrary to what some have supposed these rays are not found in sunlight, and also that they are not present in the radiations of the Welsbach light). Am Jour of Sci–May. 700 w.

5757. How to Make and Use a Simple Spectro Photometer. W. H. Birchmore (Illustrated detailed description). Pro Age–May 1. 1100 w.

5758. Carbide of Calcium and Acetylene, and Their Applications. Ed. Hospitalier (Abstract of a paper read before the Société Internationale des Electriciens. The properties of calcium carbide and of acetylene occupy a considerable part of the paper, which concludes with a review of the present and probable applications of acetylene). Pro Age–May 1. 1200 w.

5762. Southern Pine—Mechanical and Physical Properties (Relating to investigations carried on by the Division of Forestry in the laboratory at St. Louis, under J. B. Johnson and in the laboratory at Washington, by Filibert Roth. The data presented are condensed from not less than 20,000 tests, and a similar number of measurements and weighings). U. S. Dept. of Agri—Circ. 12. 5800 w.